SCIENCE

VOL. LXXIII FRIDAY, JANUARY 16, 1931 NO. 1881

The American Association for the Advancement of Science:
Engineering Culture: PROFESSOR H. F. MOORE 51
Scientific and Philosophical Methods in Education: PROFESSOR FRANK N. FREEMAN 54
Obituary:
Waldemar M. W. Haffkine: DR. DAVID I. MACHT. *E. Gley:* PROFESSOR FRANCIS G. BENEDICT. *Memorials. Recent Deaths* 59
Scientific Events:
The Monongahela National Forest; Research and Industry at Purdue University; The Franklin Institute Lectures; The Bausch Memorial Bridge at Rochester 60
Scientific Notes and News 62
Discussion:
The Barringer Meteorite: D. MOREAU BARRINGER, JR. *Concerning the Rate of Formation of Stalactites:* PROFESSOR R. W. ELLIS. *The Language of Clergymen:* THEODORE W. DARNELL, EDWARD S. ALLEN. *Babylonian Mathematics:* PROFESSOR R. C. ARCHIBALD. *An Engineer in Authority:* AN 'UMBLE SCIENTIST. *Anti-Evolution Laws:* REVEREND W. A. WILLIAMS 66
Special Correspondence:
Exhibition on the Science and Art of Color: B. 69
Scientific Books:
Jeans's The Mysterious Universe: DR. HARLAN T. STETSON. *Luckiesh on Artificial Sunlight:* DR. F. C. BROWN 71
Scientific Apparatus and Laboratory Methods:
A New Micro-manipulator: DR. G. W. FITZ 72
Special Articles:
Ovulation, Oestrus and Copulation with Consequent Dystocia during Pregnancy in the Mouse: LUCY J. WATT. *Determinate Evolution in the Genus Spirifer:* DR. CARROLL LANE FENTON. *Changes Occurring in Stored Alcoholic Plant Extracts:* DR. JAMES E. WEBSTER 75
Science News x

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

ENGINEERING CULTURE[1]

By H. F. MOORE

RESEARCH PROFESSOR OF ENGINEERING MATERIALS, UNIVERSITY OF ILLINOIS, URBANA, ILLINOIS

AT the outset of this paper it seems necessary that we should define what we mean by culture. The conventional thing to do is to quote an authoritative dictionary, but here we are met with difficulty. The word "culture" has seven or eight different definitions, varying all the way from "the details of a map which do not represent natural features of the area delineated," to the definition "refinement in manners and tastes." By some of our artist friends culture is regarded as measured by the production of works of art, while our friends the philosophers would doubtless insist that culture includes the formation of a philosophy of life. For the purposes of this paper we may perhaps regard culture as "the training, disciplining or refining of the moral and intellectual nature."

I wish to point out that taken in the sense of refinement of manners and morals, or in the artist's sense of production of works of art, a cultured man may be very narrow-minded. In Conan Doyle's novel "Sir Nigel," the young squire visits an old authority on the culture of knighthood, and the old knight is anxious above all else that this young friend always use exactly the correct word, lest he be the cause of laughter to his hearers and of grief to his friends. Especially must he recognize the fact that each species of animal has a distinctive name to designate a group. One must *never* speak of a *herd* of lions, but rather of a *pride* of lions. To speak of a *flock* of pheasants is a grievous sin against culture—it is a *nye* of pheasants. Similarly, to-day, there are many guardians of culture who are more shocked at a misspelled word (even in our quite unsystematic English spelling) than at a hazily expressed thought. Many there are who boast of themselves as liberals who are as deeply distressed as the strictest Pharisee at any infraction of any detail of the current social or literary

[1] Address of the vice-president and chairman of Section M—Engineering, American Association for the Advancement of Science, Cleveland, December 30, 1930.

code. If we limit the field of culture to literature, art and music we certainly are shutting out from any philosophy of life a consideration of many viewpoints which, be they good or evil, are certainly powerful to-day. In this paper I wish to maintain, first, that if we regard culture as the "training, disciplining, and refining of the moral and intellectual nature," we are not justified in excluding from any system of general culture a consideration of the viewpoint, either of the scientific *method,* or of the viewpoint of *applied* sicence. Why should we call uncultured the man who knows thoroughly and broadly the history and philosophy of the heat engine, but is ignorant of the music of Brahms, while we hail as cultured the musician who is a master of technique and knows the field of harmony, but is contemptuous of the applied science which has made possible the modern pipe organ.

The speaker wishes to make it very plain that he does not himself despise nor does he wish any engineer to despise the viewpoint of the philosopher, the artist, the writer, the musician, the student of literature, or the theologian. He does maintain, however, that no one of these, no, nor all of them put together, have the basis for a complete disciplining of the moral nature if they leave out of consideration the work and the methods of thought of the applied scientist. The author admires Plato, he reads his works (in translation) with interest, he is glad that Plato lived and that his work survived, but he does not believe that Plato is a complete guide for living and working.

It may be objected that the speaker has proposed so broad a field for culture that no man can thoroughly master it all. This is true. No man can master the whole field of art, of literature, of pure science or of applied science. He may, however, hope to master some part of one field and to be an interested and respectful observer of other fields. The jack of all trades and master of *none* is not an admirable figure. The speaker believes that the jack of all trades and the master of *one is* an admirable figure, and is more deserving of the title of cultured man than is the super-master of one trade who despises all others. The speaker believes that the narrow specialist, be his specialty music or hog breeding, poetry or heat engines, is frequently, especially at times of crisis, a most useful citizen, but that he does not embody a high degree of culture.

Accepting the idea that culture includes as a major object the development of a philosophy of life, the speaker believes that the engineer has some positive contribution to make to such a philosophy. Perhaps the positive contributions are not so great as the indirect, and this point will be discussed later.

One positive contribution toward a development of culture which the engineer is well fitted to make, or at least to emphasize, is the demand that the field of interest underlying such a philosophy be broadened to include not only the viewpoint of pure science but the application of that viewpoint to the affairs of daily life, and a consideration of the resultant effect upon our thinking. The speaker, so far from wishing to belittle the importance of the classical viewpoint of culture wishes to express his admiration—a rather uncritical admiration—of it, and his belief that all modern thinkers, including all engineers, might well become more familiar with the classical viewpoint. However, one characteristic attitude of that culture—the frank placing of the affairs of earning a livelihood in an *inferior* class—the writer believes to be a fault of that culture and not a virtue. An effect of that fault is plainly illustrated by the inability of the great minds of the classical world to develop the science of mechanics beyond a most elementary stage. It was not until an entirely new frame of mind came in, under Galileo—a frame of mind which in the search for knowledge, and in the development of the philosophy of life, "called nothing common or unclean"—that the science of mechanics, the first ripening fruit of the scientific age, was able to develop.

The essentially aristocratic attitude of superiority to those who have to work for a living is not necessarily snobbish, but it easily sours into snobbishness, and a contribution to a philosophy of life to the effect that no phase of life is unworthy the attention of a scholar may well be emphasized over and over again by the engineer.

A second positive contribution to culture may well be the engineer's idea of tolerance. In general we think of tolerance as a kindly, somewhat careless virtue, whereby we recognize that there is much bad in the best of us and much good in the worst of us, and so why worry much about it. To the engineer, tolerance carries an entirely different meaning. He states, for example, that in making steel for rails there is allowed a tolerance of 1/20 of 1 per cent. of phosphorus. That does not mean that he refuses to worry about phosphorus in steel. He worries about it very much, and as a result of his intelligent worrying he has decided that the cost and the time of removing that last 1/20 of 1 per cent. of phosphorus from steel is very great, whereas the evidence of material damage done by such a small amount of phosphorus is very slight. Therefore, he places the line below which it is not wise to reduce phosphorus at this figure.

This idea of this sort of tolerance of those manners and morals which seem to us undesirable is suggested

as a contribution to culture. We should by no means be good-naturedly careless about the undesirable things, but we may well try to develop a careful discrimination in choosing those evil things which we will try to eliminate and the good things which we will try to encourage, and we realize that as absolute perfection is never reached in the chemical and mechanical world, so there are limits of perfection beyond which effort in the social and ethical world is ineffective, and that these limits are not fixed, but vary from age to age.

A third positive contribution which the speaker believes the engineer may make to culture is the pointing out of the fact that not infrequently development of abstract ideals may come as the result of daily work on the job. Perhaps such development may come from the day's work as often as from abstract thinking. In the engineer's professional life the immediate thing before him is always a job, but frequently as he wrestles with a job general ideas of the relation of his job to various other jobs and of the development of various values and general truths come to him. The engineer reacts with hearty approval to that statement of the Carpenter of Nazareth, "If ye do the will ye shall know of the doctrine," and the speaker believes that the engineer may well contribute to culture by the insistence of the fact that the road between the shops of the doers of jobs and the studies of thinkers of thoughts is not a one-way street.

The speaker has mentioned what he believes to be some positive contributions of engineering to culture. These contributions make up only a small part of the body of culture, and the speaker wishes to emphasize the fact that many phases of culture are outside the professional field of the engineer, and that he should cultivate an attitude of interest toward them, even though it is not feasible for him to make direct contributions to these phases. Very few engineers can make noteworthy contributions to music, yet the engineer may well regard music as important in the scheme of things.

The speaker believes that the greatest contributions of the engineer to culture are indirect contributions. Some early records of the Christian church, at Ephesus, have been unearthed, probably for the period about 300 A. D. In those records we find that the preacher of the church was set apart to his sacred office by the solemn laying on of hands. We find that the director of the music of the church was likewise ordained to his position with the solemn laying on of hands. We find also that the janitor—the sacristan—was ordained to his office with the solemn laying on of hands. They had some good ideas in those times. Apparently they recognized that the work of the man who saw that the church building was orderly, clean, and as well ventilated as possible was worthy of sacerdotal recognition. The engineer should be regarded as a sacristan for the temple of civilized society and the office of sacristan should be restored to its ancient Ephesian dignity. For the fine arts, the fine tastes, the fine manners *may* develop amid conditions of hunger, cold, poor housing and difficult transportation, but these conditions are usually handicaps and not helps.

I would urge to engineers, first, that they accept openly and unashamed their function as smoothers of the path for the development and refinement of manners and morals. I would urge that they insist upon the dignity of this work not noisily but firmly. The great artist who paints a picture before which men and women dream is more notable than the chemist who developed for him the pigments which he used and the textile expert who has made possible the canvas on which he paints, but the artist comes short of the full stature of culture if he holds chemists and textile experts in contempt. I am asking not for formal praise to the engineer as the smoother of the path, but I am asking him to keep his own inner conviction of the worthwhileness of his task, and to honor worthy writers, painters, musicians and artists, not as a higher class of beings, but as workers who also have done well.

But we may face the fact that with the smoothing of the path to finer manners, finer tastes, finer art there has developed a great tendency for people to loiter along the smooth path making their own existence a pleasant, aimless journey. Frequently the engineer is blamed for the fact that men have used in this lazy fashion the highway he has helped to prepare, or that some of them have actually walked backward on it toward the things that are ugly and cruel. The engineer physicist who has developed the modern talking, moving picture is blamed because there has developed so large a group of people incapable of entertaining themselves and who have become slaves to professional entertainment at so much per head. The automotive engineer is blamed for the daily crowds of people who go on joy rides and frequently spoil all pleasure for others in riding. The chemical engineer is blamed for the hellishness of poison gas warfare. Some blame must be taken by the engineer for this state of affairs. In common with the great multitude of people, he has failed to raise his voice very loudly against the abuse of the smooth roadways he has made possible. He, with others, has carelessly assumed that, given an easier pathway to the fine things of life, people will of

course seek them. But his blame is not greater than that of other groups of people. He must take his share of the blame, but he is not a sinner above other men in this respect.

The engineer, with other folk, must come to recognize that while clearing the ground is an important and dignified part of the process of building the temple of society, and that while in dignity and worthiness it is second to no other task, yet the clearing of the ground does not insure that a beautiful temple will be built, and that emphasis must be placed on the proper use of the facilities he has helped create. In considering the proper use of the facilities made available by applied science—surely a field of study of vital importance to culture—the speaker believes that the engineer may well emphasize the necessity of giving due consideration to the viewpoint of the workaday world—not on emphasis which overshadows the viewpoint of the leisurely scholar who is freed from anxiety for daily bread, but an emphasis which will cause attention to be given to *both* viewpoints—a really broad-minded emphasis. He may well emphasize the engineer's idea of tolerance. Moreover he must avoid the great error, rather common to the artist type, of the tendency to see everything outside one's own field through a reversed telescope, as small and unimportant. As the engineer demands that the dignity of his work for humanity be recognized, he must be willing to give adequate recognition to the view-points of preachers and economists, artists, and philosophers, authors and pure scientists.

SCIENTIFIC AND PHILOSOPHICAL METHODS IN EDUCATION[1]

By Professor **FRANK N. FREEMAN**

UNIVERSITY OF CHICAGO

THERE is precedent for the discussion of this topic before this association. Several years ago, Dr. Pechstein, the retiring vice-president, discussed the question, "Is there a science of education?" He presented the results of a questionnaire addressed to well-known students of the science of education. He left the impression that while education may not be classed as a science similar to physics, chemistry, biology or psychology, it may use scientific methods and hence may be regarded as an applied science similar to engineering or medicine. Perhaps scientific students of education will not quarrel about a name if it be admitted that the problems of education can be attacked by scientific methods. At the meeting a year ago, Dr. Kelley discussed a question which is somewhat more nearly related to the one we have before us at this meeting. He took as his specific problem the relation between science and philosophy as methods of study of educational problems. The solution which he offered was that both science and philosophy have a place in the study of education. The place of science is to determine the general principles which govern educational procedures and the place of philosophy is to deal with and to find the solution of particular or concrete issues. When the student of education formulates a general law or principle, then, he is scientific, but, when he faces a complex situation demanding that he decide what form of practical action should be taken, he has recourse to philosophy. Science is general, philosophy is particular; science is theoretical, philosophy is practical. We shall find in the course of our discussion that concepts of the nature of philosophy and of its applications in education are varied. This is one which we shall have to include in our list for consideration.

The existence of a precedent is perhaps hardly sufficient justification for discussing the relation between the philosophical and the scientific methods on the present occasion. It is true that the recognition of education as having a legitimate place in a scientific association immediately suggests the problem. It is also true that questions of method are quite appropriate for discussion in meetings at which scientists of various interests and types of training join together. But the subject has recently been discussed in other groups as well as in this one, and it may be thought to be a hackneyed question if not indeed an academic one. I believe, however, that the problem at issue merits some further consideration. The question may be hackneyed, but there is still a marked difference of opinion upon it. The philosophy of education is made a prominent part of the curriculum of some departments or schools of education and it is omitted as a distinct subject of instruction in others. A contrast between the philosophical and the scientific mode of approach is represented not only in courses of instruction but also in the thinking and

[1] Address of the retiring vice-president of Section Q—Education, American Association for the Advancement of Science, Cleveland, December 30, 1930.

the consequent practice of teachers and administrators in general. The issue cuts deeper than a mere theoretical or a verbal adherence to one or the other side of an academic issue. The philosophical and scientific methods are not merely complementary methods, the one suited to one type of situation and the other to another. They represent differences in emphasis which characterize different modes of approach to the same problem. One of these methods is, I believe, more productive than the other and more likely to lead to progressive improvement of educational practices. For these reasons it is worth while to continue the discussion of the problem.

We often speak of philosophy and science as though we all meant the same thing and knew exactly what we meant. As a matter of fact, neither of these assumptions is true. A great variety of things is meant by both philosophy and science, particularly as applied to education, and those who discuss the issue between these two methods very commonly do not recognize that they may be talking about quite different things. It will be worth while at the beginning, then, to run over some of the diverse conceptions of these two methods.

Conceptions of the meaning of philosophy as a method are probably more varied than are the conceptions of science, so we may begin with philosophy. Philosophy is sometimes used in a technical sense to designate a rather highly specialized discipline, having a long history and a definite field which it cultivates. This is the meaning which is attached to philosophy as a subject of study in universities. Certain parts of it are highly speculative. They are dealt with in *metaphysics* or the *theory of knowledge*. They are concerned with such questions as the ultimate nature of the universe or with the possibilities or limitations of our knowledge of reality. They deal with issues which divide philosophers into camps, such as the issue between realism and idealism. These and similar questions have divided philosophers for ages and seem likely to divide them for ages to come unless they turn their backs on the problems entirely and become pragmatists.

It is a little difficult to see how metaphysics or epistemology could have a direct bearing upon practical issues in education. In fact, it is difficult to see how they have a direct bearing on practical issues of any sort. The questions with which these disciplines deal are speculative and outside or beyond the realm of immediate experience. It is sometimes held that certain assumptions concerning the issues in metaphysics are necessary as a basis for the derivation of principles in the more practical discipline of ethics; but the modern treatment of ethics deals with it through a direct analysis of experience rather than through an appeal to speculative principles. This type of speculative philosophy is not widely represented among students of education and we may, therefore, dismiss it from further consideration.

It is rather a far call from philosophy of the type which has just been mentioned to philosophy as a settler of practical, concrete, immediate issues. It is rather difficult for one who is accustomed to thinking of philosophy as dealing with such problems as the nature of reality, the nature and existence of God, the possibility or necessity of freedom, or the possibility and limits of knowledge, to think of philosophy as represented in a process of deciding whether one should spend one's money to buy a new windmill or to send one's daughter to college, or again, whether one should accept a new job which offers novel attractions or remain in the old job and enjoy the advantages which are connected with it. This is quite a different meaning of the term, inconsistent with the first one. Philosophy, according to this usage, means weighing and balancing all the considerations on one side or the other of a practical issue and then throwing the weight of one's decision on the side which presents the greater advantages. The philosopher, according to this view, is not the absent-minded recluse sitting in his study and pondering the ultimate nature of the universe. The philosopher is rather the practical man of affairs; the administrator, a person of judgment and good sense who is able to make the right decision at the right time.

Lying back of this notion, apparently, is the view that the acquirement of an adequate philosophy will in some way give the individual such ability to weigh all the values of life that when a practical issue confronts him he will be able to refer to these values and thus find the decision as good as made for him. This is an alluring prospect, but it hardly seems borne out by the facts. The connection between the more abstract or speculative considerations and the practical ones which meet the individual in his daily life is after all a rather remote one. The illustrations of practical problems offered by proponents of philosophy as suitable for solution by the application of philosophical values have not usually been elaborated sufficiently to show in detail how these values may actually be applied to the solution of the problems in question. This conception of philosophy as a settler of practical issues, therefore, seems hardly to be a tenable one.

Another conception of philosophy regards it as a personal, individual reaction to the values or goods which are presented in life. Philosophy is the subjective aspect of one's reactions. A given person may like a thing or not like a thing, but there is no appeal beyond his taste. Another person disagrees

with him, but there is no common ground for discussion, much less of agreement. Each one's evaluation of his experiences is an ultimate, and there is no means of explaining it nor, as far as I can see, of changing it. This conception is sometimes put in physiological terms by saying that science is a product of the activity of the brain and central nervous system, while the philosophical attitudes or evaluations are the product of the autonomic system. These aspects of the world which one evaluates through this purely personal and individual mode of response can not, therefore, be studied scientifically, can not be subjected to the canons of right or wrong and can not be settled by majority vote.

This argument proves rather too much. If philosophy consists in attitudes which are so inaccessible to scientific study and are so subjective as to necessitate mere acceptance without evaluation by another person, this type of philosophy would deny the very root idea of philosophy itself, which is reasoned discussion. Such attitudes can form the basis for neither philosophy nor education. A category from which there is no appeal, either by scientific study or by reasoned discussion, could never serve as the basis for educational theory. Only a type of evaluation which gave some possibility of common agreement could ever furnish the basis for educational policy or procedure.

A more common conception regards philosophy as the determiner of ends or values and science in contrast as the determiner of means to the attainment of these ends. According to this conception philosophy is commonly regarded as different in essential nature from science. It pursues different methods and in reality occupies a different dimension of thought. The two do not mix. Each one has its clearly defined area of operation. Each performs certain necessary functions within its own area but is incapable of performing the functions which belong to the other method. This conception of philosophy as having the distinct problem of setting up goals or establishing values is suited only to the absolutist's conception of the nature of philosophy. Philosophy, according to this idea, determines ends or values, not by analyzing human experience, comparing the results of this or that type of behavior in terms of human satisfaction, but rather through some speculative or abstractly logical thinking process. It is interesting to note that this view of the matter seems to be held even by some educational philosophers who professedly adhere to the pragmatic doctrine.

One of the founders of pragmatism, Professor Dewey, is quite clear in repudiating this conception of the function of philosophy in education and of its relation to science. He says in his recent essay, entitled "The Sources of a Science of Education":

> It is sometimes said that philosophy is concerned with determining the ends of education while the science of education determines the means to be used. As one who is a philosopher rather than a scientist I might be inclined to welcome a statement which confers upon philosophy such an honorable position. Without a good deal of interpretation, it is, however, likely to give rise to more false than true conceptions.

Again,

> As far as ends and values are concerned, the empirical material that is necessary to keep philosophy from being fantastic in content and dogmatic in form is supplied by the ends and values which are produced in educational processes as these are actually executed. What a philosophy of education can contribute is range, freedom and constructive or creative invention. The worker in any field gets preoccupied with more immediate urgencies and results. When one begins to extend the range, the scope, of thought, to consider obscure collateral consequences that show themselves in the more extensive time-span, or in reference to enduring development, that one begins to philosophize whether the process is given that name or not. What it terms philosophy is only a more systematic and persistent performance of this office.

In another place Professor Dewey protests against the psychologist confining himself to the study of such processes as learning to read without considering the broader effects upon the child's mental development of learning in one way or another. He says:

> It will not do for the psychologist to content himself with saying in effect: "These other things are none of my business; I have shown how the child may most readily and efficiently form the skill. The rest is up to somebody else." It will not do because one skill is acquired, other abilities, preferences and disabilities are also learned, and these fall within the province of the psychological inquirer. (sic)

It is, of course, equally true that a philosopher is not justified in saying to the psychologist, "The study of these minute details are in your province but the consideration of the larger issues are not your business at all." It is only a narrow conception of the meaning and function of psychology or of science in general which confines it to the more minute and technical problems of investigation. There is, in fact, no definite and rigid demarcation between the study of values or ends and the study of means. Professor Dewey dwells on this point emphatically. In fact, it is an essential feature of the pragmatic doctrine that values develop in the course of activity and are not worked out by abstract reflection alone and imposed upon the experience of everyday living.

If values and ends are not drawn down from the thin air, but rather grow out of our experience in meeting the exigencies of practical life and of reflection upon them, and if this reflection constitutes the method of philosophy, it is obvious that philosophy and science deal with the same material. It seems further evident that the methods are not necessarily diametrically opposed but rather overlap one another to a large degree.

The question now arises as to whether, as science develops its method of analyzing human experience, it may not offer a more refined and more reliable method of deriving values and ends than the purely observational and reflective method which characterizes philosophy. The point of view here suggested is that philosophical reflection serves provisionally as a means of evaluating procedures, but that it must give place to science as rapidly as science can perfect its methods of analysis. The values which are set up by this analysis must justify themselves in experience instead of being justified on the criterion of internal consistency, logical coherence or the appeal to individual preferences. The values must be regarded as hypothetical rather than as ultimate. The variations in values which are found to obtain in the societies of different peoples must be evaluated in terms of their outcomes in the lives of these peoples.

In attempting to evaluate forms of education, or, more broadly, forms of human organization or behavior, science seems justified in accepting a few basic assumptions, if not ultimately, at least provisionally. For example, it seems safe to assume certain conditions of body and mind as desirable and their opposites as undesirable. These are not to be regarded as ultimate ends but only as elements in a general scheme of values. General consensus of opinion would seem fairly to support the acceptance of these items as universally good: life itself, the prolongation of life, zest in life and the desire to live, a generally pleasurable feeling tone, the vigorous and effective performance of the fundamental functions of life, health of body and of mind, the development of those forms of social organization which promote these ends and the progressive enrichment of human experience. Those forms of treatment of the child and those forms of behavior which, in general, promote these and similar ends may in so far forth be regarded as worthy, and those which hinder them, in general, and in the long run, may be regarded as undesirable. These very assumptions themselves should not, of course, be regarded as beyond the pale of analysis or investigation, but the acceptance of some such assumptions will be found, I believe, to underlie our judgments concerning human values. This is true whether we think philosophically or proceed scientifically. The difference in the procedure is that, in the one case, we depend upon casual observation for the data with which to make our analyses and to draw our conclusions, whereas, in the other case, we collect our data systematically.

We have seen that in so far as philosophy deals with experience rather than with speculation, it deals with the same material as science and its methods may even shade into the method of science. The same relation holds with reference to the use of the hypothesis in thinking and in scientific investigation. Philosophers have sometimes regarded it as their function to examine the unrecognized hypotheses or assumptions which underlie the procedure of scientific workers. It is, of course, the privilege of any competent critic to examine the hypotheses which underlie the procedure of scientific workers or of speculative thinkers. Just why one group should adopt the specialized function of examiner of hypotheses, however, is not quite so clear. It would seem to be the duty of any scientific worker who undertakes to interpret the data with which he deals to examine the assumptions which underlie his own conclusions and not to rely upon someone else to perform this function for him. The person who makes scientific investigation should assume the responsibility for interpreting his data and his findings and for thinking through his arguments clearly from the foundation to the conclusion. Experimenting does not absolve the scientist from the duty of thinking and of observing the canons of correct thought. He may receive thankfully any suggestions from any qualified person whatever regarding errors in his procedure or in his interpretation, but he can not be satisfied with the division of labor which absolves him from thinking about his own findings as profoundly as he can.

A slightly different function which is sometimes regarded as a special problem of philosophy is the setting up of hypotheses. It has been pointed out that fruitful hypotheses are sometimes suggested by speculative thinkers before they have been thought of, much less tested, by scientists. The theory of evolution is cited as an example; and the laws of falling bodies, which were investigated by Galileo, constitute another example. These, however, are rather ancient instances and they occurred at a time when philosophy and science had not become distinguished from each other. The same person was likely to be both a philosopher and a scientific worker, as illustrated in the person of Aristotle. Science was in the early stages of its development when the known facts were not very numerous and the technique of scientific investigation had not been elaborated. It should be pointed out further that philosophical hypotheses, such as that of evolution, remain com-

paratively unfruitful until they are attacked by the elaborate and detailed methods of science. Furthermore, and this is perhaps a more serious matter, the speculative thinker who derives an hypothesis but is not equipped with the technique or has not acquired the habit of scientific investigation, is very likely to treat his hypothesis as a theory or even as an established principle and to neglect altogether the necessity for verification. If one does not check up on one's guesses or hypotheses by painstaking investigation it is fatally easy to pass by imperceptible stages from a guess to an hypothesis, from a hypothesis to a theory, and from a theory to an established principle. It is to be feared that much of our so-called philosophy of education consists of little more than principles derived in this fashion.

If hypotheses are to be fruitful they should be kept in as close relation as possible to observed or objectively described situations. They should grow out of actual problems which are presented concretely and in detail. They should be tested and verified or rejected by further observation, supplemented, if possible, by statistical and experimental investigations. This is the scientific method. No scientific investigation of any serious consequence can be carried on without the employment of hypotheses. They are part of the indespensable stock and trade of the scientific worker.

This fact is not only a commonplace of scientific methods; it is in strict accord with the principles of pragmatic philosophy. Pragmatic philosophy, in fact, is simply the philosophical justification of the scientific method. It means that, so far as the practical control of the affairs of living is concerned, such control must be worked out and exercised by experimental adjustment to the practical conditions of life itself. It can not be turned over to the absentee control of pure reason or speculative thought, elaborated in seclusion from the conditions which life presents and the problems which are involved in them. This means the development of principles through experimental procedure; and experimental procedure is the method of science.

It is obvious that science has been used in this discussion in the broad sense of the term. The critics of science as the predominant method of control of the procedures of education frequently restrict science to the more rigidly technical forms of scientific research, and sometimes restrict their consideration to the past achievements of science in education without regard to the possibilities of its future development. The exponent of science in education can well afford to be modest concerning its past achievements and even concerning the techniques which have been developed up to the present time. The contention is not that science has yet established a basis for all the procedures of education or even for a considerable part of them. For the length of time it has been in operation, the scientific method has given a fair account of itself. The main contention of this paper is that it is the scientific method rather than the philosophical method which offers the possibility of continuous and sure advancement toward a more and more adequate solution of the problems of education. When science has once conquered a bit of territory, that territory is acquired in permanent possession. Mistaken theories may be adopted which are later shown to be unfounded, but in general science moves steadily onward.

Genuine philosophical speculation has its own canons of criticism. It may, within its own sphere, be as rigid and as careful as is scientific investigation. Those who pursue philosophical speculation, however, recognize the limitations of its sphere. They do not undertake to make it do a work for which it is not fitted, namely, to determine the issues of practical living. One who is not interested in the pursuit of speculative philosophy may adopt pragmatism, which eschews speculative problems and busies itself with the problems of practical living. Such a person must realize, if he thinks his way to the end, that the ultimate goal of such a procedure is a wholehearted adoption of the scientific method. He can not stop at any half-way point. If he does, he abandons the canons of one rigid discipline without taking over the canons of the other discipline which properly takes its place.

The issue is one of practical importance. The contrast between what often passes for the philosophy of education and the pursuit of the science of education is too often the contrast between a method of thought in which the thinker is unwilling to take the laborious and painful course of checking up his opinion step by step and the method in which the attempt is made to subject one's thinking to careful verification. The habit of building up a structure of opinion without constant and painstaking weighing of evidence and without constant reference to particular facts for the purpose of verifying and correcting these opinions is all too easy to acquire and all too difficult to outgrow. No one would probably lay claim to having entirely outgrown this insidious habit. It is within the province of every one, however, to declare his commitment to a method which requires that opinion shall grow out of detailed examination of all the facts pertinent to the problem, and as complete a testing of his opinion as the technique at his command will

allow. In dealing with those problems to which the scientific method of investigation has not yet been successfully applied we shall all need to philosophize, that is, to use our best judgment in the light of the facts which are available to us. This philosophizing, however, can best be done as an integral part of the consideration of each particular educational problem. There is no justification for setting apart those aspects of educational problems on which the evidence is not yet complete and treating them in a separate discipline. Furthermore, we may look forward to the gradual reduction in the scope of problems which must be attacked by this method, and we should use our best efforts to enlarge the scope of those problems which may be successfully attacked by the scientific method.

OBITUARY

WALDEMAR M. W. HAFFKINE

THE sudden death on October 27 in Lausanne at the age of seventy of Dr. Waldemar M. W. Haffkine, bacteriologist and immunologist, deprives the world of one of its most illustrious scientists. Inasmuch as Haffkine's work in combating and, to a large extent, conquering epidemic scourges was of universal benefit and inasmuch as his career as an investigator was truly international—being carried on under the auspices of various nations and races—it is appropriate to devote a few words of appreciation to his memory in SCIENCE.

Dr. Haffkine was born in Odessa, in southern Russia, on March 15, 1860. At the age of twelve he entered the gymnasium at Berdiansk and from the very first he exhibited a bent of mind in the direction of science and experimental investigation. In 1879 he entered the University of Odessa as a student in the faculty of science and in 1883 he took his degree of doctor of science. He remained at Odessa for five years, working in a laboratory fitted out for his special use in connection with the zoological museum of the university, and devoted himself to the study of difficult problems relative to the fundamental phenomena of organic life. At the beginning of 1888 he was appointed assistant to Dr. Schiff, professor of physiology in the University of Geneva, a position which he held for a year and a half. About the middle of 1889 he found his true sphere of work on being called by Pasteur to Paris. He became one of Pasteur's most eminent pupils.

In Paris he began the study of typhoid fever and cholera and soon discovered the principle and method of inoculation with attenuated virus against the latter. As early as 1891 his work along that line had progressed so far that when Prince Damrouy, brother of the King of Siam, called on Pasteur and asked him to supply a remedy for cholera, the illustrious scientist referred him to Haffkine for aid. A few months later Haffkine's first paper on the subject was given to the world.

The two of Haffkine's most important contributions to the science of medicine are his investigations of the devastating scourges, cholera and the plague. It is perhaps in connection with cholera that Haffkine is better known. In 1893 he went to India to conduct investigations on cholera for the Indian Government, making Calcutta his headquarters and extending his operations over the whole of Bengal and into the Punjab, the Northwest Province and Assam. In 1896 he was deputed by the Indian Government to inquire into the bacteriology of the plague and to devise means of combating it. Here again he discovered an effective method of inoculation and succeeded in reducing the mortality from 80 to 90 per cent. In recognition of his services to the British Government, he was created Companion of the Order of the Indian Empire. The Haffkine method of inoculation for both cholera and plague has been generally adopted throughout the Orient, and the government research laboratory which he founded issues many thousands of doses of vaccine for the effective inoculation and treatment of epidemics in various tropical countries.

Haffkine's contributions to biological research and medicine include various monographs and official reports not only on the cholera and the plague but also on a variety of other subjects, heredity, biology of monocellular organisms, general problems of bacteriology, etc. Although retired from active work for the past few years, he continued to interest himself in various scientific investigations, which he carried on particularly at Lausanne.

Haffkine's work on cholera and the plague places him in the class of those pioneers in medical research who have immortalized their names through the alleviation of suffering and reduction of mortality caused by such wide-spread infections as malaria, diphtheria, yellow fever and trypanosomiasis. As a scientist, Haffkine was meticulously careful and accurate in his work as well as ingenious in his methods. As a man, his character might be summed up in the following words, a quotation from a letter received by the writer from Dr. M. Ascher, Bex, Switzerland, who attended the funeral: "Great was his scientific work in that he literally saved millions of lives but equally great was the personal character of the man and, most particularly, his modesty and humility. He never asked for help from any man but he was always ready to help

others and befriend the needy." The memory of Waldemar M. W. Haffkkine will be cherished not only by those who had the privilege of being his friends and those who are devoted to the advancement of medical science but also by all those interested in the promotion of human welfare and the betterment of the race.

DAVID I. MACHT
DIRECTOR, PHARMACOLOGICAL RESEARCH LABORATORY, HYNSON, WESTCOTT & DUNNING, INC., BALTIMORE, MD.

E. GLEY

To American biologists has come the tardy news of the death of Professor E. Gley on October 28. Professor Gley endeared himself to every one with whom he came in contact. In spite of his seventy years, his electric vitality enthused every one about him. Those who heard his address at the International Congress of Physiologists at Stockholm in 1926 and the address given at the International Congress in Boston in 1929 recognized in him not only the savant but a man of the widest international interests. One of the first to extend the hand of friendship to the opposed nations of the war, Professor Gley has done a great deal to reestablish international amities. About his hospitable table at his home in Paris one could be sure to meet a representative of nearly every country of Europe. His loss will be very severely felt by the Collège de France, for in a relatively short time the Station Physiologique has lost not only M. Pézard but now Professor Gley. Working with a wholly inadequate laboratory and under almost impossible conditions, Professor Gley maintained high scientific standards and his loss to biological science as a whole is irreparable. Ever expressing his enthusiasm for France, Professor Gley was extraordinarily international-minded and not only has biology lost a great scientist and France a great citizen, but the world has lost a great man.

FRANCIS G. BENEDICT

MEMORIALS

A MEMORIAL meeting to the late Dr. Thomas W. Salmon was held at the New York Academy of Medicine on January 10. The committee in charge has collected $100,000 to establish a permanent memorial. This will take the form of an award to be made each year to a psychiatrist who has, during that period, made distinguished contributions in the field of psychiatry and mental hygiene. He also will be chosen to give the Thomas W. Salmon lectures. Speakers at the memorial meeting included Mr. George W. Wickersham, chairman of the committee, and Dr. Harry Emerson Fosdick.

THE College of Forestry of Syracuse University was closed at 12:00 o'clock January 5 for the balance of the day in honor of the memory of Professor John W. Stephen, head of the department of silviculture. Professor Stephen, after having joined the faculty of forestry as one of its pioneer members in 1912, was soon promoted to the rank of professor, and was appointed head of the silviculture department in which capacity he has served since. The books and articles which he wrote concerning his field of work include "Making Best Use of Idle Lands in New York," "Basket Willow Culture in New York," "Forest Conditions in Oneida County," and "Top-Lopping of Branches in Lumbering Conifers." Professor Stephen was a native of Michigan and was graduated from both Michigan Normal College and the University of Michigan. He received an A.B. degree in 1907 and an M.S.F. degree in 1909 from the latter institution. While on leave from Syracuse University in 1915, he received the degree of M.Ped. from Michigan Normal. He became a state forester in New York in 1908, being given charge of the state tree nursery at Salamanca. He was a member of Sigma Xi fraternity, a fellow of the Society of American Foresters and a member of Phi Kappa Phi, honorary scholastic fraternity.

RECENT DEATHS

DR. HENRY LEFFMANN, professor of chemistry at the Wagner Free Institute, Philadelphia, an honorary member of the Franklin Institute, died on December 25. Dr. Leffmann was eighty-three years of age.

DR. CHARLES KRUMWIEDE, professor of hygiene and bacteriology at New York University and assistant director of the New York Health Department's research laboratory, died on December 28, at the age of fifty-one years.

MR. GEORGE G. AINSLIE, associate entomologist of cereal and forage insect investigations of the Bureau of Entomology at West Lafayette, Indiana, died on December 19.

THE death is announced of Professor John Munro, emeritus professor of mechanical engineering at the University of Bristol at the age of eighty-one years, and of Professor Eugene Goldstein, of Berlin, at the age of eighty years.

SCIENTIFIC EVENTS

THE MONONGAHELA NATIONAL FOREST

EIGHT meetings were held at various points contiguous to the Monongahela National Forest on January 5, for the purpose of taking concerted action at a general meeting toward securing an adequate allocation of forest funds for the construction of roads and trails and the relief of the unemployed.

Initial action was taken by the Elkins Business

Men's Association and a letter was sent out recently calling meetings at the courthouse at Petersburg, Grant County; at the courthouse at Franklin, Pendleton County; at the Durbin Junior High School in Pocahontas County; at the courthouse at Marlinton, Pocahontas County; at the Board of Trade Office at Davis, Tucker County; at the Glady Church, in Randolph County; at the Stockmans Bank at Harman, and at the Young Men's Christian Association at Elkins.

Three things were to be considered at these meetings:

Plans for obtaining the allocation of $400,000 for the construction of roads and trails and for the relief of unemployed.

How to secure approval of four projects as recommended by the United States Forestry Service at Elkins. These four projects embrace the construction of a road from Corners, in Grant County, to Upper Tract, in Pendleton County, known as the Smoke Hole project; the construction of a road from Porterwood, in Tucker County, to Harpertown, in Randolph County, known as the Shavers Fork project; from Bartow, in Pocahontas County, to Judy Rocks, in Pendleton County, known as the Elk Mountain project, and from Hendricks, Tucker County, to Red Creek, known as the Dry Fork project.

The appointment of a committee of three from each community to meet in Elkins, when there would be perfected an organization to promote the development of Monongahela Forest, which constitutes one of the general conservation projects of the government through the reforestation of the area.

RESEARCH AND INDUSTRY AT PURDUE UNIVERSITY

RAPID development of research work at Purdue University in connection with the industrial growth of the state was emphasized with the filing of articles of incorporation of the Purdue Research Foundation. The organization of the foundation marks another epoch in the influence of the university and gives a new impetus to the extensive research program of scientific research.

The foundation is a non-profit organization and has no capital stock. Its purpose is to assist in the financing of the research projects and handling of matters pertaining to inventions and patents for the benefit of the state at large, the university and industrial organizations directly concerned.

Calls upon the university by industries of Indiana, especially during the last few years, for assistance in solving scientific problems vital to their growth have increased with the growing economic importance of the state in national affairs. Recognizing the need for more constructive cooperation the board of trustees of the university in 1927 authorized organization of a special department to handle research relations with industry. Mr. G. Stanley Meikle, a well-known consulting engineer, was chosen director of the newly created department. As a result of his work, direct cooperation between industry and the university has grown rapidly. This has led to the organization of the foundation to assume the legal and financial responsibilities of the rapidly expanding research program.

The board of directors for the foundation, representing the founders, the board of trustees of the university, Purdue alumni, and the national engineering and research councils, includes the names of widely recognized men. The names of the directors follow: J. R. Francis, Flint, Michigan, president of the Marvel Carburetor Company; J. K. Lilly, Indianapolis, president of Eli Lilly and Company, and trustee of Purdue; David E. Ross, Lafayette manufacturer and inventor, and president of the Purdue Board of Trustees; G. Stanley Meikle, director of research relations with industry; L. A. Downs, Chicago, president of the Illinois Central Railroad; L. W. Wallace, Washington, D. C., executive secretary of the American Engineering Council; President E. C. Elliott, of the university; James W. Noel, Indianapolis attorney, and James L. Kimbrough, Muncie, treasurer of the Indiana Bridge Company, both trustees of the university; Robert M. Feustel, Fort Wayne, executive vice-president of the Midland United Company, and president of the alumni association; D. M. Buchanan, Chicago, president of the Old Ben Coal Corporation, and William L. Batt, of New York City, president of the S. K. F. Industries, bearing manufacturers.

FRANKLIN INSTITUTE LECTURES

THE following lecture program has been arranged by the Franklin Institute of Philadelphia:

January 15.—Dr. Charles A Kraus, director of chemical research, Brown University, on "Solutions of Metals in Non-Metallic Solvents: Some of their Physical and Chemical Properties."

January 21.—Igor I. Sikorsky, vice-president, Sikorsky Aviation Corporation, Bridgeport, Connecticut, on "The Future of Large Aeroplanes."

January 29.—Dr. George A. Richter, director of research, Brown Company, Portland, Maine, on "Researches on Wood Fibers as a Paper-making Material."

February 5.—Dr. Arne F. Westgren, secretary for physics and chemistry, Nobel Prize Committee, Stockholm, Sweden, on "Crystal Structure and Atomic Products of Alloys Containing Transition Elements."

February 18.—Dr. K. C. D. Hickman, research laboratory, Eastman Kodak Company, Rochester, New York, on "High Vacuum Technique in Chemical Work."

February 26.—Dr. V. K. Zworykin, engineering department, research division, R. C. A. Victor Company, Inc., Camden, New Jersey, on "Photo Cells in Theory and Practice."

March 5.—Dr. Judson Daland, Graduate School of Medicine, University of Pennsylvania, on "The Evolution of Modern Printing and the Discovery of Movable Metal Type by the Chinese and Koreans in the Fourteenth Century."

March 18.—Dr. Walter Renton Ingalls, director, American Bureau of Metal Statistics, New York City, on "The Wealth of Nations, With Especial Reference to That of the American People."

March 26.—Dr. Samuel A. Mitchell, director, McCormick Observatory, University of Virginia, on "The Structure of the Atom Under Conditions of Temperatures and Pressures in the Sun's Atmosphere."

April 2.—Captain Nicholas H. Heck, chief, Division of Terrestrial Magnetism and Seismology, U. S. Coast and Geodetic Survey, on "Earthquakes and the Engineer."

April 9.—Nevin E. Funk, vice-president in charge of engineering, Philadelphia Electric Company, on "The Economic Value of Major System Interconnections."

April 15.—Dr. W. F. G. Swann, director, Bartol Research Foundation of The Franklin Institute, on "Report on the Work of the Bartol Research Foundation."

THE BAUSCH MEMORIAL BRIDGE AT ROCHESTER

ON New Year's Day, the city of Rochester dedicated its newest and finest span across the Genessee River as the Bausch Memorial Bridge in honor of John Jacob Bausch, the founder of the Bausch & Lomb Optical Company. The tablet unveiled during the dedication exercises has the inscription here reproduced.

This tablet was unveiled by Eleanor Eisenhart, great granddaughter of John Jacob Bausch, after a speech by Dr. Rush Rhees, president of the University of Rochester:

BAUSCH MEMORIAL BRIDGE
ERECTED 1930
BY THE CITY OF ROCHESTER
**
BY THE WILL OF THE PEOPLE A MEMORIAL TO
JOHN JACOB BAUSCH
PIONEER MANUFACTURER AND INDUSTRIAL LEADER, WHO GAVE ROCHESTER LEADERSHIP IN AMERICA'S OPTICAL INDUSTRY.

A correspondent in sending us this information writes:

In many ways this is regarded as a most fitting tribute. The first bridge to span the river at this point was built in 1873 and the following year the first company-owned Bausch & Lomb plant was built immediately adjacent to it. The plant and the bridge have "grown up together" and it is a coincidence that the new Bausch Memorial Bridge was built in the year that marked the one hundredth anniversary of the birth of John Jacob Bausch.

John Jacob Bausch was born in Gross Suessen, Germany, July 25, 1830. He died in Rochester, New York, February 14, 1926. Perhaps no more fitting epitaph to his life may be found than that written by his own hand. "My life has been a modest one, and was for a long time a struggle for existence. With heavy toil and in the face of many difficulties I was forced to meet its exigencies in early years. Failures have frequently fallen to my lot, but I have never given up hope, and have been astonished frequently at the success which has crowned my efforts in the end. Of a peaceful disposition by nature I have maintained pleasant relationships with my fellow men. Spiritually and morally I have always sought to do my best and have dishonored my family with no stain."

One fortunate circumstance, the importance of which can hardly be overestimated, was his friendship with Henry Lomb. Dating almost from the beginning of his struggle in America this partnership which was spiritual as well as material endured through every vicissitude until they were parted by the death of Captain Lomb, in 1908.

SCIENTIFIC NOTES AND NEWS

FOR the centenary meeting of the British Association, to be held in London from September 23 to 30 under the presidency of General Smuts, the following sectional presidents have been appointed: Section A (Mathematical and Physical Sciences), Professor Sir J. J. Thomson; B (Chemistry), Brigadier-General Sir Harold Hartley; C (Geology), Professor J. W. Gregory; D (Zoology), Professor E. B. Poulton; E (Geography), Sir Halford Mackinder; F (Economic Science and Statistics), Professor E. Cannan; G. (Engineering), Sir J. Alfred Ewing; H (Anthropology), Professor A. R. Radcliffe Brown; I (Physiology), Dr. H. H. Dale; J (Psychology), Dr. C. S. Myers; K (Botany), Professor T. G. Hill; L (Educational Science), Sir Charles Grant Robertson; M (Agriculture), Sir John Russell. On Wednesday, September 23, the ceremony of installing General Smuts as president of the association and a reception of delegates will be held in the Albert Hall during a private view of the exhibition which is being arranged in connection with the Faraday centenary celebrations.

THE Perkin Medal, awarded annually "to the American chemist who has most distinguished himself by his services to applied chemistry," was presented at Columbia University on January 9 to Dr. Arthur D.

Little, of Cambridge, Massachusetts, at a joint meeting of the Society of Chemical Industry, the American Chemical Society, the Société de Chimie Industrielle and the American Electrochemical Society. Dr. Little spoke on "The Evaluation of Chemical Projects." Other speakers were Professor Frederick G. Keyes, of the Massachusetts Institute of Technology, and Professor Marston T. Bogert, of Columbia University. A dinner at the Faculty Club preceded the meeting. The Perkin Medal was founded in 1906 at the time of the Perkin semi-centennial celebration of his coal-tar discoveries, the first medal being awarded to Sir William H. Perkin himself.

DR. ADOLF MEYER, professor of psychiatry at the Johns Hopkins University and director of the Henry Phipps Psychiatric Clinic at the Johns Hopkins Hospital, was made on January 10 the first recipient of the lectureship award under the recently established Thomas W. Salmon Memorial. The award carries an honorarium of $2,500 to be given annually to a man chosen to deliver the lectures at the New York Academy of Medicine because of his outstanding contribution to psychiatry.

THE Stephen Hales prize "in recognition of service to the science of plant physiology" was awarded to Dr. W. W. Garner, physiologist in charge of tobacco and plant nutrition investigations, U. S. Department of Agriculture, at the annual meeting of the American Society of Plant Physiologists, held at Cleveland on December 29, 30 and 31. This award, established in 1927 by the society in honor of the pioneer plant physiologist for whom it is named, consists of a diploma and a cash sum and was awarded to Dr. Garner for his discoveries of the effect of the length of day on the growth of plants.

DR. WILLIAM H. WELCH, professor of the history of medicine at the Johns Hopkins University, was elected president of the History of Science Society at the recent Cleveland meeting.

PROFESSOR GEORGE GRANT MACCURDY, of Yale University, director of the American School of Prehistoric Research, was elected president of the American Anthropological Association at the recent annual meeting of the association held in Cleveland.

PROFESSOR GEORGE JAMES PEIRCE, of Stanford University, has been elected president of the California Botanical Society.

THE council of the Royal College of Surgeons of Canada recently conferred the honorary fellowship of the college on Dr. Frederick G. Banting, of the University of Toronto, co-discoverer of insulin.

AT a recent joint meeting of the board of trustees and scientific governors of the Chicago Academy of Sciences, the following honorary curators were elected: invertebrate paleontology, Dr. John R. Ball, of Northwestern University; paleobotany, Dr. Adolf C. von Noé, University of Chicago; botany, Dr. H. S. Pepoon, now associated with the Illinois Natural History Survey; mammalogy, Mr. Tappan Gregory; entomology, Dr. Frank J. Psota; oology, Mr. E. R. Ford. The Chicago Entomological Society, the Illinois Audubon Society, and the State Microscopical Society of Illinois have recently become affiliated with the academy as sections.

DR. FREDERICK BECKE, professor of mineralogy in the University of Vienna, celebrated his seventy-fifth birthday on December 31.

Nature calls attention to the birthday anniversaries last month of three British veteran workers in science. It writes: "On December 12 last Professor W. C. Unwin, 'a master and teacher of the science of engineering'—to use the appraising words of the late Sir William White—entered on his ninety-third year. He was born at Coggeshall, Essex, in 1838, educated at the City of London School, and began his notable technical career as a pupil in the firm of William Fairbairn, Manchester. Professor Unwin was elected to the fellowship of the Royal Society in 1886. Dr. William Garnett, who was born at Portsea, will celebrate his eightieth birthday on December 30. Like Professor Unwin, he was educated at the City of London School. Proceeding to St. John's College, Cambridge, he graduated fifth wrangler. Entering the Cavendish Laboratory, Dr. Garnett enjoyed the distinction of being the first demonstrator of physics there under James Clerk Maxwell. From 1904 until 1915, Dr. Garnett was educational adviser to the London County Council. Professor S. H. Vines, who was elected a fellow of the Royal Society in 1885, will be eighty-one years of age on December 31. A graduate of Christ's College, Cambridge, he was formerly Sherardian professor of botany in the University of Oxford."

AT the annual meeting of the Mineralogical Society of America, which was held at Toronto from December 29 to 30, in conjunction with the Geological Society of America, the following officers were elected for 1931: *President,* Alexander H. Phillips, Princeton University; *Vice-president,* William F. Foshag, U. S. National Museum, Washington, D. C.; *Treasurer,* Waldemar T. Schaller, U. S. Geological Survey; *Secretary,* Frank R. Van Horn, Case School of Applied Science; *Editor,* Walter F. Hunt, University of Michigan; *Councillor 1931–34,* William S. Bayley, University of Illinois.

AT the annual meeting of the Mathematical Association of America the following officers for 1931 were elected: *President* (two years), Dr. E. T. Bell, of the California Institute of Technology; *Vice-presidents,* Professor Arnold Dresden, of Swarthmore College, and Professor C. N. Moore, of the University of Cincinnati; *Members of the Board of Trustees* (for three years), Dr. L. L. Dines, of the University of Saskatchewan; Dr. T. C. Fry, of the Bell Telephone Laboratories; Dr. J. W. Glover, of the Teachers Insurance and Annuity Association, and E. P. Lane, of the University of Chicago.

DR. EDWARD A. BOYDEN, professor of anatomy at the University of Alabama, has been appointed to succeed Dr. Richard E. Scammon as professor of anatomy at the University of Minnesota. Dr. Boyden will move to Minnesota on June 1.

ANNOUNCEMENT is made of the appointment of William Maughan as assistant director of Duke Forest and assistant professor of forestry in Duke University, effective on January 1. Mr. Maughan's first work at Duke University will be to organize the Duke Forest as an operating demonstration of research and forestry in cooperation with Dr. C. F. Korstian, director of the forest and professor of silviculture. Plans are being formulated to develop a program of research which will be followed eventually by the organization of forestry educational work. This will probably be graduate work, largely of a research nature, leading to the higher degrees in forestry.

DR. HUGH E. BURKE has assumed his work as director of the research laboratory at the New York State Tuberculosis Sanatorium, Ray Brook, succeeding Dr. David T. Smith, who, after five years' service, resigned to become associate professor of medicine at Duke University School of Medicine, Durham, N. C.

THE appointment of W. P. Yant, supervising chemist of the health laboratory of the U. S. Bureau of Mines, as supervising engineer of the Pittsburgh Experiment Station of the U. S. Bureau of Mines, Department of Commerce, is announced by Scott Turner, director of the bureau. Mr. Yant succeeds G. St. J. Perrott, who has accepted a position on the research staff of the A. O. Smith Corporation, Milwaukee, Wisconsin.

CHRIS L. CHRISTENSEN has resigned as secretary of the Farm Board to become dean of the College of Agriculture at the University of Wisconsin. Prior to his association with the Farm Board since its organization in July, 1929, Mr. Christensen for three years was head of the division of cooperative marketing of the Department of Agriculture.

MR. T. W. FAGAN has been appointed to the professorship of agricultural chemistry at University College, Wales.

MR. W. J. PUGH has been appointed professor of geology and director of the geological laboratory of the University of Manchester, from September, 1931.

DR. DAVID RIESMAN, professor of clinical medicine in the University of Pennsylvania School of Medicine, has been appointed consultant to the committee on the costs of medical care.

SIR GEORGE NEWMAN will be Heath Clark lecturer at the University of London for the year 1931.

THE Medical Research Council has, according to the *British Medical Journal,* awarded three Dorothy Temple Cross Research Fellowships for 1930–31, these being the first appointments to be made under the terms of the recent benefaction in that name for research fellowships in tuberculosis, as follows: Arthur Ivan Granville McLaughlin, chief assistant, tuberculosis department, St. Thomas's Hospital, London; Reginald John Matthews, chief tuberculosis officer, Mid-Glamorgan area, and medical superintendent, Cymla Hospital; Sidney Malcolm Burrows, lieutenant, attached Sudan Defence Force. Dr. McLaughlin has received a fellowship for the study of methods of diagnosis and treatment at some chosen center in the United States. Dr. Matthews and Lieutenant Burrows have received senior fellowships, and will make special studies of problems of tuberculosis among the native populations in Zanzibar and in the Bahr-el-Ghazal province of the Sudan, under arrangements made by the council with the respective governments.

DR. S. A. MAHOOD, of the department of chemistry of Tulane University, is on leave from the university for the session 1930–31, and is spending the year on special synthetic work in organic chemistry as Squibb's Research Fellow at Yale University.

DR. FRANZ ALEXANDER, of the University of Chicago, delivered the fourth Harvey Society lecture at the New York Academy of Medicine on January 15. His subject was "Psychoanalysis and Medicine."

DR. ELWOOD MEAD, commissioner of reclamation in the Department of the Interior, gave an illustrated lecture on "The Boulder Canyon Project" in the Aldred Series at the Massachusetts Institute of Technology on January 9.

PROFESSOR JAMES H. MCGREGOR, of Columbia University, gave on January 13 an illustrated lecture on "Primitive Man" before the Middletown, Connecticut, Scientific Association.

SIR D'ARCY POWER, of London, spoke on "The Royal Gift of Healing" before the College of Physicians of Philadelphia on December 8.

THE annual meeting of the American Heart Association will be held on Monday, February 2, at the Academy of Medicine, New York City.

THE First Congress of Latin American Ophthalmology will be held at Santiago (Chili) in 1931, under the presidency of Professor Charlin.

THE French Government has accepted an offer of the Rockefeller Foundation to establish a center for the study of undulant fever at Montpellier.

ADDITIONAL details in regard to the new observatory to be erected near Toronto by Mrs. D. A. Dunlap and her son, D. Moffat Dunlap, as a memorial to the late David A. Dunlap, who died in 1926, have been sent to us by a correspondent. Its distinguishing feature will be a 74-inch reflecting telescope, which is now being constructed by Sir Howard Grubb, Parsons and Co., of Newcastle-on-Tyne, England. Sir Charles Parsons, the proprietor of this firm, is the youngest son of the Earl of Rosse, who built the famous 6-foot reflector at Birr Castle some eighty-five years ago. The great telescope will be housed in a circular sheet metal building, as is usual now, while the offices and other necessary accommodation, together with auxiliary instruments, will be in a separate building which will be fine architecturally. The observatory will be located not far from Toronto but the exact site has not been determined. It is intended to have it in the midst of a park. When completed the observatory will be presented to the University of Toronto and will be under the department of astronomy.

AT a recent meeting of the deans of the professional colleges and the director of Hooper Foundation for Medical Research of the University of California, it was voted to apply the term, "Medical Center," to the schools, colleges and research centers considered collectively. The Medical Center is now taking steps to protect California from tropical and Oriental diseases which might be brought in through development of world commerce. To centralize efforts in this direction the regents of the university recently authorized the inauguration of a Pacific Institute of Tropical Medicine, and this organization is now functioning on many projects.

A CHEMICAL map of North America, the first attempt of its kind to show the wide range of sources of medicinal chemicals, has been prepared by Professor H. V. Arny, dean of the College of Pharmacy, Columbia University, and E. L. Newcomb, secretary of the National Wholesale Druggists Association. The map, in five colors, represents all countries from the Panama Canal Zone to Hudson Bay. Names of ores, minerals, chemicals and elements appear approximately at the point of origin. Countries, states and provinces are shown in yellow; oceans and lakes in blue; political boundaries and important cities in red; mountains in sepia, and rivers and most type matter in black. In the border are photographs and sketches of mining operations and chemical plants.

ADDITIONAL canyons were on January 5 added to the Bryce Canyon National Park, in southwestern Utah, by the proclamation signed by the President, upon the joint recommendation of the Secretary of the Interior and the Secretary of Agriculture. The park, as established in 1928, contained the remarkable Bryce Canyon, a horseshoe-shaped amphitheater cut by erosion into one of Utah's colorful plateaus and filled to the brim with a myriad of fantastically carved figures. The original boundaries, however, did not take in some adjoining canyon country needed to complete the park. Congress, realizing this, authorized the president to add additional lands, and the recently promulgated proclamation increases the park area from 14,480 to 30,560 acres. The newly-acquired lands were transferred from the Powell National Forest. The addition ranks in scenic grandeur with that portion included in the original park and includes a great crescent of eroded area in the Pink Cliffs with an air-line distance between tips of eight miles which gives an incomparable display of color. It has been likened to a giant rainbow fallen over on its side. From one elevated point in the newly added territory there is a circle of unobstructed vision of at least 320 degrees. From it on a clear day mountain ranges in the five states of Utah, Arizona, Colorado, New Mexico and Nevada may be seen. In this view, looking from southwest to southeast, the foreground is the magnificently eroded, brilliantly-colored area breaking into the Colorado River.

THE University of Florida, under the auspices of the committee of university publications, has inaugurated the issuing of a series of research monographs, under the general heading of Biological Science Series, Physical Science Series, etc., in which research work will be published from time to time by the university. The first of these monographs to appear was published May, 1930, under the title "A Contribution to the Knowledge of Florida Odonata" by Dr. C. Francis Byers. Other works are in progress. The University of Florida publications are offered in exchange for the publications of learned societies and institutions, universities and libraries.

THE annual report of the Science Museum, South Kensington, issued by the Board of Education, records the visit in 1929 of 1,061,754 members of the public, an increase of 161,700 over the figures for 1928. In August, 1929, the monthly total reached the record number of 144,655, while the total number

for the first six months of the present year has been 100,000 above that of 1929. The attraction of the museum (especially the working models) to children is noted, and the purpose of a special children's gallery or galleries set forward. The advisory committee comment gratefully upon the support received from industrial firms, institutions and private individuals in the form of gifts and loans, which have totalled 1,150, apart from three exhibitions. Willingness to offer objects of historical worth and interest to the museum maintains the collections, it is observed, at a trifling cost to the state. The need for the center block of new buildings is described as urgent, since it is space which is lacking to show current practice in the various collections of the museum, rather than willingness to lend. The lectures given normally by guide-lecturers were attended by 20,845 persons, compared with 10,600 in 1928. Special lectures were given to 3,851 persons, composing 155 parties, and 7,000 persons also visited the museum in parties under their own arrangements. The work of extending the library periodical collections has been extended, and both periodicals and books have been lent in increasing numbers.

DISCUSSION

THE BARRINGER METEORITE

I WAS much interested in Professor Fairchild's article, in SCIENCE for November 7, 1930, on the "Nature and Fate of the Meteor Crater Bolide." Especially was my attention attracted because he presents therein a completely new conception of the extra-terrestrial body that made the crater. He visualizes it as a single, stony meteorite, containing nodules or segregations of metallic nickel-iron; further, he conceives of the stony part (the major part) of the body having been totally destroyed by the impact and by subsequent weathering, leaving only the minor iron nodules, of which many representatives have been found.

The article, while extremely interesting, is not convincing in its proof of the above hypothesis. May I call attention to some of the reasons why my brothers and I have not been persuaded by it to alter our conception (which was my father's) of the body? That theory visualized the body as a compact swarm of nickel-iron meteorites, containing in all probability no stony individuals whatever. Professor Fairchild appears to ignore this theory, but raises several objections to the bolide's having been a solid spheroidal mass of iron 400 feet or so in diameter. Such a body would certainly not fulfil some of the conditions found at the crater, and the idea has not been seriously entertained by us.

Many of the iron individuals, or parts of individuals, of the swarm contained sufficient chlorine to cause rapid oxidation on exposure to ordinary atmospheric conditions. Those that had been so exposed before the discovery of the crater were promptly converted to the hydrated oxides of iron and nickel, giving rise to the material known as "iron shale." But quite a number of others, dug up since the discovery of the crater, were found to have been so well protected by the rock flour of crushed sandstone grains from the Coconino that oxidation had made little or no headway in them. Upon exposure to the air they oxidized rapidly, some of them going entirely to oxide in a year or two. Others, of course, have been preserved in paraffin. Still others exhibited unoxidizable nuclei, which stayed metallic and bright even after years of exposure.

From this it is seen that burial in the rock flour around the crater was a nearly perfect protection from all forms of erosion, for of course no frictional erosion could have taken place without breaking the air-seal and allowing penetration of oxygen. Now a great many iron meteorites have been found in the silica by trenches and shafts. But not a single stony meteorite, or a single piece of rock in any way foreign to the normal geology of the region, has so far been discovered. If the original mass had consisted largely, or even partly, of stone, and if any stone had survived the impact, some of it would without question have been preserved in the ejected débris.

To this argument Professor Fairchild replies that all the stone was destroyed at the instant of impact, leaving only the metallic nuclei broken entirely free of their matrix. This means that not even a minute chip or fragment of stone could have survived, or remained adhering to the iron, for some of it would otherwise have been found. Such complete destruction is hardly conceivable. Meteoric stone is usually of the nature of a dense crystalline igneous rock, certainly harder and more resistant than the soft Coconino sandstone, and probably just as tough as the Kaibab limestone. Yet great masses of the Kaibab escaped the pulverization supposed to have been meted out to the stony bolide, and even boulders of the Coconino were thrown out of the hole at the moment of impact without great damage to themselves. That part of the Coconino which was in immediate contact with the impinging mass should have been even more seriously affected than the mass itself. Yet

we find pieces of that sandstone close enough to have been stained by nickel-iron vapors, and liquefied by the friction of the mass itself, but still clearly recognizable as products of the Coconino sandstone. Had there been any appreciable amount of meteoric stone involved in the impact it would seem impossible that evidence of it should not have been found.

I have elsewhere[1] summed up the reasons for believing the impacting mass to have been a compact cluster of millions of small, rounded individuals, rather than a single mass of iron (or stone) or a single large mass accompanied by a few satellites. This conception of the body coincides with the accepted belief as to the nature of comets. One of the reasons for this conception is that most, if not all, of the Canyon Diablo irons, when in their original condition (*i.e.*, when not acted upon by terrestrial erosion) are of a rounded or oval outline. This is explained by the long-continued attrition between individuals of the clusters, attrition that may have been very slow, but that had millions of years in which to accomplish its results. If, then, the cluster had contained at its inception any appreciable number of stony individuals, they would have been subjected to exactly the same process as that which takes place in a ball mill; that is, they would have been chipped and shattered to total disintegration long before the iron members had been worn away. The dust they became would have been blown away from the comet by the pressure of light if the comet had ever come near the sun; if not, it would at least have been filtered out of the swarm at the first touch of the earth's atmosphere.

Professor Fairchild mentions the pitting of the typical Canyon Diablo irons, ascribing it (and I think rightly) to the removal of some enclosing matrix from around the unoxidizable iron. But this matrix he believes, from no evidence that I know of, to have been stone. There is strong evidence, on the other hand, that the matrix was not stone but the oxidizable variety of nickel-iron, for a good many of the pittings are partially filled with iron oxides, firm in texture and adhering closely to the iron. Also, as I have mentioned above, some of the oxidizable but metallic individuals preserved in the rock flour show unoxidizable nuclei. Here is clear evidence that the matrix which originally enclosed the Canyon Diablo irons was chlorine-bearing iron. There is no evidence to indicate it to have been stone.

The rounded shape of the original irons (for all the fragments found preserved in the rock flour were rounded) also argues against their having been inclusions in a large mass of stone. Many stony meteorites exhibiting iron inclusions are known, but those inclusions show no evidence of rounding, being on the contrary of irregular, angular shapes, filling spaces between crystals or chondrules of the enclosing matrix, or ramifying through the rock as irregular veinlets. Why should a large hypothetical siderolite exhibit such a totally different structure from the known small ones?

One stony meteorite was found at the crater, or rather at a distance of a mile or so from the rim. This is mentioned in my father's paper[2] of 1909, and part of it is now in the Meteor Crater collection in the Guyot Museum at Princeton. It was distinctly an individual piece, hardly to be thought of as a chip from a larger mass, and had markedly rounded outlines. As is pointed out in my father's paper, there is strong reason for believing that this was a separate and later fall than the Meteor Crater swarm.

Interesting as Professor Fairchild's conception of the Barringer meteorite is, he has presented no new evidence in support of that conception, and his conclusions from the old evidence do not warrant, to my mind, a change from the more accepted picture of the comet. My father's visualization of the celestial intruder, as a cluster of small rounded iron meteorites, containing in all probability no stony members or parts, still has all the evidence in its favor. But, though we differ from Professor Fairchild in this particular conclusion, I am deeply sensible of his long and helpful interest in the question, and of his frequent and sturdy assistance in the problems connected with it.

D. MOREAU BARRINGER, JR.
HAVERFORD, PENNSYLVANIA

[1] *Scientific American*, July, August, September, 1927.

CONCERNING THE RATE OF FORMATION OF STALACTITES

DURING the past summer I visited old Fort Pickens, on the west end of Santa Rosa Island, opposite Pensacola, Florida. In prowling around one of the dismantled structures, I came upon a room the ceiling of which held a number of stalactites. Considerable stalagmitic material also covered the floor. This unusual occurrence of deposits aroused my curiosity, as I thought they might throw some light on the rate of deposition of certain cave deposits.

The room where the stalactites were found was made of brick, laid in lime mortar. Both the walls and the roof were four or five feet thick. The roof was somewhat overgrown with vegetation growing from loose earthy material covering the brick. There were ample openings in the walls for a free circulation of air, yet not situated so as to allow violent winds to strike the interior. The conditions seemed quite similar to those of a limestone cave, as far as the formation of stalactites was concerned.

[2] "Meteor Crater," by D. M. Barringer, read before the National Academy of Sciences, November 16, 1909.

The largest of the stalactites were about the size of a lead pencil and about 10 inches long. All were quite fragile.

As to the time required for these depositions no definite statement can be made. The fort was in use during the Civil War, and it is likely that the roof remained in fair condition for thirty years longer. The impression received was that the rate of deposition had been much greater than is commonly thought to be the case in the growth of limestone cave deposits. It is thought that the stalactites had not very recently been disturbed, as the floor deposits were fairly commensurate with the amount of material still hanging to the ceiling. The rate of deposition may have been an inch a year. And the entire deposit came from the meager supply of limy material contained in the mortar of the brick roof.

R. W. ELLIS

UNIVERSITY OF NEW MEXICO

THE LANGUAGE OF CLERGYMEN

I HAVE read the article entitled, "The Language of Scientists," by the Reverend George W. Lay, with a great deal of pleasure. Some of the mispronunciations to which he calls attention are really delightful. Certainly every scientist should be meticulous in the use of scientific terminology. But I wonder if it is not equally important for theological scientists to be somewhat careful of the structure of sentences. In Mr. Lay's amusing castigation of his fellow members of the Association for the Advancement of Science, I see this amazing statement: "An example of ignorance or carelessness appeared in an important paper by an eminent scientist that was published in SCIENCE." I want to congratulate the publisher who undertook so stupendous a task as that. We have all heard of books that are published, but this is the first time that I, for one, have ever heard of publishing an eminent scientist. Later in his article, Mr. Lay writes: "These words are practically always derived from the Latin or the Greek . . . ." Does he mean that they are *usually* so derived? Still later, the supercritical (or is it hypercritical) Mr. Lay gives us this charming bit of English: "Attention has been called recently to two examples of unscientific confusion in the meaning of words." Perhaps Mr. Lay would be good enough to tell us what *scientific* confusion would be like. One more delightful bit of English meets us near the end of his article. He writes: "Scientists can not even trust each other." Are there, then, but two scientists who are thus antagonistic? Perhaps all scientists distrust *one another*. I have no doubt that Mr. Lay is quite correct in all his pronunciations, but a good rhetoric would tell him that there is as great a danger in misplaced phrases and misused words as in misplaced accents. If we are to carry culture into the laboratory, by all means let us expand the meaning of the word "culture" to include correct sentence structure.

THEODORE W. DARNELL

NEW YORK, N. Y.

"THE Language of Scientists" was certainly worth publishing. However, it suggests to me two questions. Mr. Lay speaks of a "co-ed graduate student." Are all participants in coeducation female?

He states later that one micromicron is a thousand times greater than another. Is it possible that he meant "a thousand times as great as"? Or, if you will, "999 times greater than"?

EDWARD S. ALLEN

BABYLONIAN MATHEMATICS

IN SCIENCE for December 12, 1930, page 601, Professor G. A. Miller writes: "The Babylonian mathematics is of special interest in view of the fact that our division of the circle into 360 parts called degrees, and our division of the degree and the hour into 60 parts called minutes and of the minute into 60 parts called seconds can be traced back thereto." May I suggest that nothing would be of greater interest to readers of SCIENCE than a presentation of references to *sources* where these various statements may be checked? Cantor makes no such claim, nor does he, in his references to Babylonian geometry, give adequate references to sources to check even the statement he does make: "for a certainty we have the division of a circle into 6 parts, then into 360 degrees." Heath reproduces no such statement. Tropfke in the third edition (1930) of Volume 1 of his history does not furnish proof of Professor Miller's claims. In 1928 Thureau-Dangin argued merely that the division of a circle into 360 parts was natural, but that further sexagesimal division was unnatural. During the past year I have given in SCIENCE[1] some references suggesting the difficulty, in the present state of our knowledge, of arriving at any definite conclusion in this regard.

R. C. ARCHIBALD

BROWN UNIVERSITY

DECEMBER 13, 1930

AN ENGINEER IN AUTHORITY

MOST scientific men were delighted when for the first time since George Washington an engineer be-

[1] SCIENCE, 71, 117–118, January 31, 1930; 71, 342, March 28, 1930. Many more detailed references are given in my "Bibliography of Egyptian and Babylonian Mathematics" in Chace's edition of the Rhind Mathematical Papyrus, 1927 and 1929.

came President of the United States. It is, however, said that Mr. Hoover, as a member of the cabinets of Mr. Harding and Mr. Coolidge, did not support the scientific work under his charge, and there seems to be no evidence since he has climbed to the presidency that he realizes the dependence of our civilization on scientific research and its applications.

As secretary of commerce Mr. Hoover indeed appointed a commission on highway safety, but he allowed the members to pay their own traveling expenses and took no notice of them, though he managed to have it called in the extensive newspaper publicity the "Hoover Commission."

Every president in recent years has welcomed to Washington the members of the National Academy of Sciences, which is the official scientific adviser of the government and of which President Hoover is perhaps the only member elected for reasons other than eminence in scientific research. It is said that at receptions at the White House Mr. Roosevelt and Mr. Wilson were able to greet by name a considerable percentage of the members. President Hoover apparently has not noticed the existence of the academy.

It is understood that President Hoover was officially invited to address the recent Cleveland meeting of the American Association for the Advancement of Science and the national societies devoted to the social and economic sciences, meeting together for the first time, but refused, though he could have spoken by radio from Washington. He has been more obliging in other instances, as witness the following editorial article from the *Journal* of the American Medical Association:

THE PRESIDENTIAL FINGER SLIPS

Norman Baker, of Muscatine, Iowa, who claims to treat successfully cancer, goiter, varicose veins and other diseases by some secret preparations, who uses his radio station to sell cigars and get patients, who attacks most of the reputable educational institutions and scientific organizations of his state and of the nation with billingsgate and vilification, found it necessary to start a newspaper to spread his views because the reputable press of his state exposed his quackery. By some of the strange influences known only to politicians, President Herbert Hoover was induced to apply to a pushbutton in Washington the presidential digit, thereby giving to the presses in Muscatine the electrical juice necessary to induce motion, whereby inked rollers applied to paper aided still further the dissemination of Baker's notions and nostrums. As an engineering feat, the demonstration must have given joy to the presidential cerebrum. As a demonstration of presidential judgment and a sense of the fitness of things, it gave acute pain to the press, the physicians and most of the people of Iowa. Somewhere, somehow, some secretary succeeded in precipitating the President of the United States into a situation that awaits explanations.

The writer asks that the publication of his name be omitted, for while it is improbable, though highly desirable, that President Hoover should read this communication, it might come to the attention of some member of his kitchen cabinet, and if so there would be no chance of appointment to a vacancy that may occur on the Federal Power Commission.

AN 'UMBLE SCIENTIST

[It need scarcely be said that a journal is not responsible for opinions expressed by contributors, least of all in the correspondence columns. It is, however, responsible for the acceptance of contributions, and this anonymous criticism of the President has been printed with some hesitation. It seems, however, that the relations of officers of the government to science should be freely discussed in a scientific journal, and that there may be good reasons, especially for those in the federal service, to withhold their names. SCIENCE will welcome communications describing Mr. Hoover's contributions to engineering and his support of science before and since his elevation to the presidency.—EDITOR.]

ANTI-EVOLUTION LAWS

AN effort should be made, this winter, in every state, to secure by legislative enactment or vote of the people, a law prohibiting the teaching of the brute origin of man in tax-supported schools and colleges, since the false "science" of evolution is the chief support of infidelity and atheism.

I shall be glad to send free a copy of my "Evolution Disproved" by 50 convincing scientific arguments, to all members of committees considering such bills, and will send a copy free to 5000 lawmakers, if given $1000 (one-fifth of price) which I shall also donate to missions, doubling all gifts at my cost.

Will you kindly insert this notice for the sake of the truth and the protection of the youth?

REVEREND W. A. WILLIAMS

CAMDEN, N. J.

SPECIAL CORRESPONDENCE

EXHIBITION ON THE SCIENCE AND ART OF COLOR

COLORS have come to play so important a part in modern life that this third decade of the twentieth century promises to be known as the "Age of Color," according to Professor Charles R. Richards, of the Museum of Science and Industry of New York, who has just announced the holding of an "Exhibition on

the Science and Art of Color" to be given at the museum's headquarters in the *Daily News* Building at 220 East 42nd Street, from January 20 to March 15.

"The exhibition will be the first comprehensive effort yet made to indicate the use and future possibilities of color in virtually all departments of modern life and will bring to the public a better understanding of both the scientific and artistic aspects of color."

Many of the latest discoveries in the color fields, never before made generally known to the public, such as photography of ranges of color invisible to the human eye and hitherto declared "unphotographable," and machines which may ultimately displace the erratic color sense of the human eye, will be on display at the exhibition.

The exhibition will be held in collaboration with leading American scientists, artists, technicians, engineers and educators and will be open daily without charge, from 10 A. M. to 5 P. M. Exhibits will range from colored kitchen utensils and other articles in the home, to clothes, decoration, reading material, food products, color in transportation, manufacturing and industrial processes, and give glimpses of the kaleidescopic cities of the next century.

In addition to numerous exhibits of color arranged by the museum itself, more than two hundred outstanding scientific, industrial and business organizations will make displays. Individual exhibits will number in the hundreds, ranging from the scientist's spectroscope and intricate color producing machinery to colored articles in daily use.

A distinctive feature of the exhibition will be an unusual arrangement of the exhibits in six major groups, permitting the layman as well as the expert to follow in logical progression from the initial group illustrating the nature of color on to groups illustrating color production, color as seen by the human eye, the measurement and specification of color, examples of color materials, and concluding with exhibits of color applications.

Many exhibits will be visitor operated. Switches and levers will permit the visitor to make his own demonstrations. A color printing press will be in actual operation, and daily demonstrations of instruments and apparatus will be given. Guides will explain many of the more complicated scientific items, and plans have been made for a series of lectures during the course of the exhibition by well-known physicists, chemists, psychologists, artists, designers, illustrators and others in the various fields of color.

"Because of the profound effects which color and its wise use may contribute to our lives, and the general appeal to all which color makes, the museum has undertaken to demonstrate to the public the great scientific and artistic advances recently made," Professor Richards stated. "For the first time, color will be presented not only from any one standpoint in a single field, but from the inclusive standpoints of the scientist, the artist, the psychologist and the technician, and an endeavor made to correlate them. The exhibition will provide an opportunity for the general public to view concrete examples of the amazing range and diversity of color uses, and to see color processes rarely available outside the walls of laboratories and in complicated technical industries."

In asserting that we are probably on the threshold of a new era in the use of color, Professor Richards voiced the opinion that "this third decade of the twentieth century might be characterized by future generations as the real beginning of the age of color."

Cooperating with the museum in the exhibition are included the following: Arthur S. Allen, color consultant; Dr. George D. Beal, Mellon Institute; Charles Bittinger, artist; Carl Foss, International Printing Ink Co.; Dr. H. P. Gage, Corning Glass Works; L. A. Jones, Eastman Kodak Company; Dr. M. Luckiesh, General Electric Company; Paul M. Rea, National Lead Company; A. L. Powell, General Electric Company; Dr. H. H. Sheldon, New York University, and Dr. J. L. Stair, Curtis Lighting, Inc.; Dr. E. E. Free, Dr. H. H. Howe, Dr. C. E. K. Mees, Eastman Kodak Company; A. E. O. Munsell, A. J. Powers, Dr. R. R. Rose, E. I. duPont de Nemours and Company; Dr. G. W. Thompson, National Lead Company; Dr. Maximilian Toch, Dr. L. T. Troland, Technicolor Motion Picture Corporation, and Dr. E. R. Weidlein, Mellon Institute.

Among the exhibitors will be: American Bank Note Company, Bakelite Corporation, Bausch and Lomb Optical Company, U. S. Bureau of Agricultural Economics, U. S. Bureau of Standards, Cheney Brothers, Claude Neon Lights Company, Columbia University, Consolidated Gas Company, Crane and Company, Curtis Lighting, Inc., E. I. duPont de Nemours and Company, Eastman Kodak Company, General Electric Company, Fisher Bodies Corporation, Norman Bel Geddes, Grasselli Chemical Company, Johns Mansville Company, Lord and Taylor, R. H. Macy and Company, Mellon Institute of Industrial Research, Associated Munsell Companies, National Lead Company, New Jersey Zinc Company, Baltimore and Ohio Railroad, New York Telephone Company; Remington-Rand Company, Sherwin-Williams Company, Shubert Theater, Stehli Silk Corporation, Strathmore Paper Company, Technicolor Motion Pictures Company, Warner Research Laboratories, Westinghouse Lamp Company, and Carl Zeiss, Incorporated.

B.

SCIENTIFIC BOOKS

The Mysterious Universe. By SIR JAMES JEANS. ix + 154 pp. Cambridge University Press, 1930. 3*s* 6d.

To those who have read Sir James Jeans's "Universe Around Us," his latest volume, "The Mysterious Universe," will prove an appropriate supplement. As the earlier volume was largely descriptive and astronomically informative, the latest book from his pen is largely philosophical and is a fitting interpreter to the facts presented in the earlier publication.

As explained in the foreword, the book is an amplification of the subject-matter presented in the Rede Lecture, delivered at the University of Cambridge in October, 1930.

In the opening chapter on "The Dying Sun," the author gives us a picture of a decadent future with all the pessimism of classical thermodynamics.

With a brisk transition, however, the reader meets in chapter two the "New World of Modern Physics." Here the revolutionary changes in fundamental concepts considered inviolate a generation ago give a far different picture of the universe than the mechanical conception of the engineer scientists of the Kelvin and Maxwell era.

In kinetoscopic fashion, he traces the metamorphosis of the radiation concepts from the undulatory theory of Huygens and Thomas Young, through the quantum theory of Planck to Schroedinger's wave-mechanics and Heisenberg's principle of indeterminism.

A chapter on relativity follows, with remarks on the astronomical consequences of the Einstein and DeSitter conception of space and time. The non-astronomical reader may be somewhat confused in the discussion of the "reddening of stars," where change in the wave-lengths of the spectral lines involved, due to various causes, is the real issue.

In chapter three, Jeans describes the significance of modern physical theories and stellar evolution leading to the startling concepts of the annihilation of matter through radiation. The possible significance of cosmic rays in this connection, and the hypothesis of Millikan that interstellar space sees the recreation of matter through absorption of cosmic radiation is discussed quite uncolored by the author's own views, although he thinks the probabilities are against such an hypothesis.

Chapter four, on "Relativity and the Ether," recounts the observational evidence at the basis of the theories of relativity. It is, perhaps, not surprising that Jeans makes no mention of the results of D. C. Miller in repeating the Michelson and Morley experiment, but one is a bit surprised to infer from the reading that the experiment was first carried on by Michelson and Morley at the University of Chicago instead of at the laboratory of the Case School in Cleveland, at which Miller's subsequent repetitions were performed.

From relativity the author progresses "Into Deep Waters," the title of chapter five. Here he pursues a philosophical and mathematical inquiry bordering on metaphysics. One sees in this volume a philosophy convening toward much the same end as has marked the recent writings of Eddington. Perhaps the most significant statement of Jeans's evaluation of the trend of modern physical science is to be found in the final paragraphs of the volume.

> To-day there is a wide measure of agreement, approaching almost to unanimity, that the stream of knowledge is heading towards a non-mechanical reality; the universe begins to look more like a great thought than like a great machine. . . . And with this reflection before us, we may well conclude by adding, what might well have been interlined into every paragraph, that everything that has been said, and every conclusion that has been tentatively put forward, is quite frankly speculative and uncertain. We have tried to discuss whether present-day science has anything to say on certain difficult questions, which are, perhaps, set for ever beyond the reach of human understanding. We can not claim to have discerned more than a very faint glimmer of light at the best; perhaps it was wholly illusory, for certainly we had to strain our eyes very hard to see anything at all. So that our main contention can hardly be that the science of to-day has a pronouncement to make, perhaps it ought rather to be that science should leave off making pronouncements: the river of knowledge has too often turned back on itself.

HARLAN T. STETSON
THE PERKINS OBSERVATORY

Artificial Sunlight. By M. LUCKIESH. 254 pp. Illustrated. D. Van Nostrand Company, Inc., New York.

THIS book, like most of this author's works, carries forward a definite theme supported by concise and digested data to a seemingly indisputable conclusion, and this makes the book useful to those interested in illumination and health. Likewise, the book is characteristic in that the author's naturalistic philosophy is a premise and a safeguard in the development.

Perhaps this thread may be epitomized by saying that, since the human race has been able to survive and thrive through countless generations with sunlight, sunlight therefore must have in it the necessary elements of radiation to support well-being and efficiency. Just as, although nature originally provided hair on the body and perspiration as protection from cold and heat, man by scientific means and otherwise learned to use clothing, shelter and artificial heating to supplement what nature provided, so, while nature has been very successful, a scientific analysis should enable us to increase the efficiency of society by artificial sunlight. This phase of the presentation should make the book interesting reading to the philosopher, the student of nature and all those who have not a deadened intellectual curiosity.

The opening sentences are most illuminating. "Nature is beneficent—life-giving—but also ruthlessly destructive. Its eternal shower of blessings has not effaced or even dimmed the edict that only the fit shall survive." In the first chaper on "A New Era of Lighting" is shown how man's striving to supply the elements of sunlight in his machine age living has resulted in the development of lamps that supply the requisite character of illumination and the needed ultra-violet light.

In the chapter on the sun's beneficence is given not only an array of historic facts and modern scientific data supporting the theses that sunlight, generally speaking, supports good health, but the argument is made more impressive by a chart showing the relation between the death-rate in the different months of the year and the hours of sunshine corresponding thereto. The chapter on solar radiation is essentially a digest of some of the leading workers in this field. On the basis of these data he concludes that artificial sunlight must be developed more or less independently of natural sunlight, but he does not imply that all the elements known to be useful should not be preserved.

Dr. Luckiesh has supplied the underlying data for designing lighting installations, of artificial sunlight with the various sources and filters available. Although considerable work remains to be done in conserving the requisite ultra-violet component, nevertheless the practical application is already within engineering reach.

Beginning with the fifth chapter, the book consists very largely of the author's data. It is very interesting to note that the carrying out of the problem requires the development of paints for ceilings so that indirect lighting can be used, but where this is not feasible it is always possible to resort to special fixtures, of which many have been designed and several have been built.

F. C. BROWN
MUSEUM OF SCIENCE AND INDUSTRY,
NEW YORK

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A NEW MICRO-MANIPULATOR

Is there a worker with a micro-manipulator who does not wish that his instrument possessed more than merely smooth and exact control in three dimensions; whose impatience has not suggested improvements to facilitate his operations? Suggestions gathered from various laboratories go far to define the ideal manipulator, which should conceivably have the following characteristics:

1. Simple and quick gross adjustments to the microscope, giving a wide range of orientation.

2. Means for immediate return of the point to its operating position after withdrawal of the micro-manipulator for the setting or changing of the moist chamber, etc.

3. Grouped controlling handles which permit instant selection and actuation by the fingers of one hand without distraction of attention.

4. Coordination of the motion of each controlling handle with the resultant motion of the operating point, producing, as observed under the microscope, "natural" or expected movement.

5. Complete bilateral symmetry in double instruments through a right- and left-hand arrangement of controls.

6. Identical direction of the motion of each pair of corresponding controls in double instruments to secure identical movements of the respective operating points.

7. Compactness and directness of action, even in combination with a micro-injector, which will permit inclination of the manipulator to an acute angle with the optical axis of the microscope for operations on tissues and organs *in situ* in living animals.

8. Rugged and wearproof moving and bearing parts, so that proper use will not limit the life of the instrument.

An original solution of the mechanical problems involved in micro-operations is offered in the design of a micro-manipulator by the writer, here first publicly described. The special features of this design are covered in applications for patents now pending.

A diagrammatic general view of a double manipulator in relation to a microscope is shown in Fig. 1.

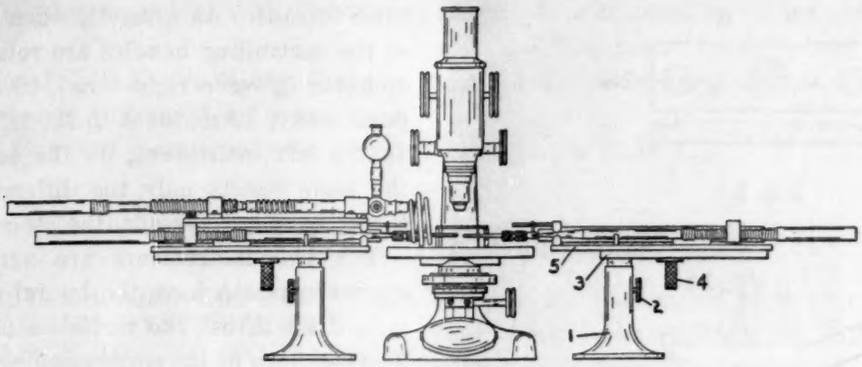

FIG. 1.

To the right-hand instrument is attached a removable micro-injector, applicable to either side. The manipulator is supported on a hollow pedestal 1 which receives the stem of a bracket 3 and holds it at any level by means of the clamp screw 2. The bracket has a broad top with a 4-inch slot through which a screw from the base 5 of the manipulator freely slides, but may be clamped as desired by the nut 4.

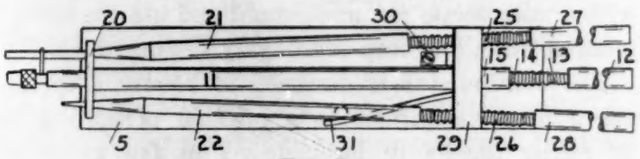

FIG. 2.

The manipulator itself, which rests upon the shelf of the bracket, is best shown in Fig. 2.

The main axis, Fig. 3, is a tubular casing 11 which

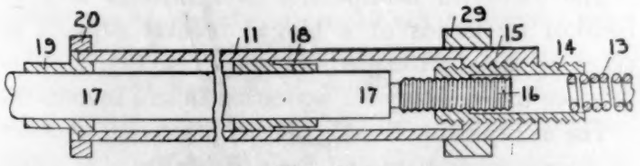

FIG. 3.

encloses the thrust mechanism and guides the thrust rod 17, whose extension carries the operating point. To avoid the serious disadvantages of an extremely fine screw for the control of the thrust motion of the point, a differential screw system has been used (14, 15, 16) which is as direct acting, but permits the use of strong and durable screw threads, *viz.*, 32 and 40 to the inch.

The system is actuated by the handle 12, acting through the spring wire coil 13 upon the hollow screw 14. As the screw in one complete rotation advances one thirty-second of an inch into its nut 15, the screw 16 is drawn back one fortieth of an inch into its nut in the inner end of the screw 14. The advance of the rod 17 and consequently of the operating point is, therefore, their difference, which is 0.00625 inch or 0.156 mm. This is equivalent to one rotation of a single acting screw with 160 threads to the inch (6.4 to the mm) and is amply fine for work under the highest usable power. The actuating handle is small and, therefore, may be rapidly rotated between the thumb and finger for quickly adjusting the operating point.

The rod 17 is supported by close-fitting spring sleeves attached to the guides 18 and 19, which prevent all side motion and thus insure a pure thrust of the operating point. The thrust rod terminates in a tapered stud on which may be slipped corresponding hollow couplings (B. D. subcu needles) carrying operating points.

The motions of the operating point laterally and vertically are produced by cam or wedge action, as shown in Figs. 2 and 4. The end of the tubular axis

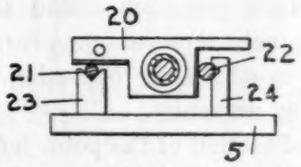

FIG. 4.

11 carries the cross-plate 20 with horizontal and vertical V bearing edges, which are held by appropriate spring action firmly against the cone extensions of rods 21 and 22 lying in their corresponding notches in pins 23 and 24. The cone-ended rods are flexibly attached to the screws 25 and 26, which are threaded through the cross-bar 29.

It is evident that when screw 25 is rotated by its handle 27 to advance rod 21, the cone 21 will push under the horizontal V edge of plate 20 to lift it. It, thereby, raises the operating point. Similar rotation of screw 26 will obviously throw the operating point sidewise.

These two motions, vertical and horizontal, are centered at the cross-bar 29 by the method of its attachment to the base 5, as shown in Figs. 5 and 6. The cross-bar rests on two balls and thus is free to move horizontally and, by tipping, vertically about the horizontal axis connecting the two balls. The center for the horizontal motion lies in the screw pin 30, which

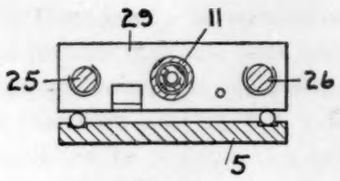

FIG. 5.

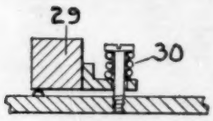

FIG. 6.

passes through a hole in a short offset from the cross-bar 29. This screw pin is surrounded by a coil spring which, pressing strongly on the offset, throws the cross-plate 20 down upon the cone 21 and its notched supporting post 23 and at the same time firmly seats cross-bar 29 upon its supporting balls in their cups in base 5.

The lateral control is secured similarly by the elastic pressure of spring 31, which forces plate 20 and the intervening cone 22 horizontally against the side notch of post 24. These springs insure that there will be no backlash in the response of the operating point to the movements of the cones.

The cones are integral with their steel rods and are hardened, ground, and polished to a true form to insure perfectly uniform and steady control. They taper 0.157 inch per inch. The screws have 32 threads to the inch; therefore, one turn of each screw causes a movement of the operating point of 0.155 mm laterally or vertically.

The range of motion of the point in fine adjustment is 6 mm in each of the three dimensions, which gives 3 mm each way from the midpoint at which the controlling screws should be kept. Since the bracket stem and base clamps permit easy and quick adjustment to less than 1 mm, this range is ample.

The use of a setting guide to locate the optical axis of the microscope and the height of the cover-glass of the moist chamber makes a preliminary setting of the point very accurate and simple.

The flexible connections between the screws and the cone rods are necessary, since the rods vary their alignment to the screws and thus would bind or be thrown out of their notches if made integral. They are used between the handles and screws to avoid adventitious movement of the whole apparatus when the handles are actuated. By their use, the apparatus can be made much lighter and less cumbersome without sacrificing essential rigidity.

To coordinate the handle motions with those of the apparent operating point, the right manipulator has all the adjusting screws—14, 16, 25 and 26—with left-hand threads. As a result, when the upper surfaces of the controlling handles are rotated away from the operator (given a right turn), 28 moves the apparent point away, 12 moves it to the left, and 27 lowers it. In the left instrument, on the contrary, to produce the same results only the differential screws of the thrust have left threads, the others having right.

The two instruments are arranged in bilateral symmetry: both have the lateral control on the near side of the thrust, the vertical control on the far side. The rotations of the corresponding controlling handles are, moreover, identical to produce the same direction of movement of the two operating points.

The selection of the proper handles and the conscious coordination of their movements to the corresponding movements of the apparent operating point or points is thus made so essentially simple, even in the double manipulator, as to become quickly automatic. This ease of use is increased by the open construction of the mechanism, its simplicity of design, and its directness of action. That any one familiar with a microscope can understand and use the instrument at once, has been thoroughly demonstrated.

The manipulator is designed to receive a special micro-injector-aspirator in a position permitting its operating handle to be included in the group of manipulator controls (Fig. 1). Convenience and rapidity of operation are thus insured to this line of work. A detailed description of this injector will be given later.

The combined manipulator and injector may be inclined by means of a hinged bracket support in place of the right-angled one shown in Fig. 1, so as to reach into a cavity for operation *in situ* in animals.

The manipulator is designed to operate either under or over a cover-glass and from either the side, front or rear of the optical axis of the microscope. For convenience, in the front and rear approaches, the shaft of the removable operating point unit is bent at right angles, thus permitting the two points of the double instrument to enter one opening of a moist chamber. The front approach is shown in Fig. 1. It is obvious that there are no changes in the relations of the controls.

By means of an attachment not shown in the figures, it is a simple matter to return the operating point to its former position in the field after sliding it away for the placing of the moist chamber, etc. By using both the point setter and the position duplicator, one can fix the point in the optical axis at the proper height, set the duplicator, slide the manipulator away, adjust the moist chamber into its position, slide the manipulator back and find the point in the optical axis ready for work. With a little additional care

it is also possible to change points with the same result.

From the above description it will be seen that the new micro-manipulator is presented as a universal instrument, adapted to micro-operation in its widest range. It is believed by its designer and by its sponsors, the Bausch and Lomb Optical Company, to have met the laboratory requirements as above outlined.

G. W. FITZ

PECONIC, L. I., N. Y.

SPECIAL ARTICLES

OVULATION, OESTRUS AND COPULATION WITH CONSEQUENT DYSTOCIA DURING PREGNANCY, IN THE MOUSE

As has been pointed out recently by Swezy and Evans[1] two cases of copulation during pregnancy were observed by Long and Evans[2] in the course of their observations on the rat. Nelson[3] also reported a case of oestrus in the rat, occurring at regular intervals during pregnancy, with copulation taking place at three of these intervals. Swezy and Evans report that the cycle of ovogenesis is not interrupted during pregnancy in the rat, for they observed the periodic appearance of mature follicles and young corpora lutea in the ovary throughout gestation, although they were not able to demonstrate the presence of ova in the oviducts.

I have recently noted a case in which ovulation occurred during pregnancy in the mouse, and furthermore, as in the case reported by Nelson, copulation occurred as was evidenced by the presence of a vaginal plug. During routine examination this mouse which was in labor was observed to be in distress. Examination showed the presence of a vaginal plug which was so firmly attached that it could not be removed by means of a forceps. The animal was observed at intervals from 8:30 A. M. until 11:00 A. M. Frequent strong muscular contractions occurred, after which she made attempts to deliver the young. She was left alone, and at 3:45 P. M. observations were again continued. At this time she was still in labor, but three young had been born. The vaginal plug was found adherent to the vulva and apparently had been forced out by the muscular contractions on the first young to be born. The placenta was attached to one of the dead newborn young, suggesting that the mother probably was too fatigued to dispose of it properly. Since vigorous, periodic labor contractions were still occurring frequently with no results, the animal was killed at 4:30 P. M., or eight hours after she was first noticed to be in labor. Six fetuses, two of which were alive, were found in the uterus. No movements were observed in the other four, which were still in loco.

Histological examination of the ovaries and oviducts showed that ovulation had occurred. One ovary contained eight young corpora lutea which were about seven hours old, according to Allen's[4] criteria for the age of corpora lutea. The distal portion of the corresponding oviduct contained eight ova. The other ovary contained three seven-hour corpora lutea, and three ova were found in the oviduct. Ovulation evidently had occurred synchronously, because the ova were clumped together and were surrounded by discus cells. Fertilization had not yet taken place, for all but two ova contained the second maturation spindle. These two appeared to be in the prophase of the second maturation division. Twenty-one mature follicles were found in one ovary and sixteen in the other, an unusually large number.

The mouse, a virgin, had been put with a male on May 14. Neither a vaginal plug nor the placental sign had been observed. Twenty-two days later a vaginal plug was found, although pregnancy had not terminated. Presumably the gestational period was of normal length, since the litter did not appear more mature than usual.

It is apparent from these things that not only did ovulation occur during pregnancy but that it was accompanied by oestrus and copulation, the influence of the corpora lutea of pregnancy being insufficient to suppress ovulation until after parturition, as is usual. The number of mature follicles in the ovary suggests the possibility of hyperactivity of the hypophysis, with consequent formation of more than the usual number of follicles, which in turn might secrete sufficient folliculin to cause oestrus to be superimposed upon pregnancy.

This case, together with that of Nelson and the observations of Swezy and Evans, suggests that superfetation may occur during pregnancy in the mouse and hence also in allied forms, provided that ovulation takes place either before the closing of the uterine lumen due to the gestational changes, or after reestablishment of the lumen, before the advent of parturition. If it occurred in the first instance, the difference in the age of the fetuses in the same litter

[1] O. Swezy and H. M. Evans, "Ovarian Changes during Pregnancy in the Rat," SCIENCE, 71 (1828): 46, January 10, 1930.

[2] J. A. Long and H. M. Evans, "The Oestrus Cycle in the Rat and its Associated Phenomena," *Memoirs of the University of California*, 6, 1922.

[3] W. O. Nelson, "Oestrus during Pregnancy," SCIENCE, 70 (1819): 453, November 8, 1929.

[4] E. Allen, "Oestrus Cycle in the Mouse," *Am. J. Anat.*, 30, 1922.

should not be more than four or five days, though it might be less, because of some variability in the length of the oestrus cycle, as well as in that of gestation. Such a course of events might explain the cases in which some of the young of the same litter are much smaller than the rest.

On the other hand, if ovulation occurred after the reestablishment of the uterine lumen, the birth of full-term young about sixteen days after the previous litter might be accounted for, though I have found no reports of such cases. However, since implantation would not occur until the fifth day, that is, until after parturition, in such cases, they could not be considered true cases of superfetation, unless the onset of pregnancy were counted from fertilization rather than from implantation.

In the cases cited by King[5] and Sumner[6] in which from twelve to fourteen days elapsed between two consecutive litters it is conceivable that the first pregnancy may have been confined to one horn of the uterus and that subsequent ovulation resulted in implantations in the other horn, a possibility which was suggested by King.

I wish to express my sincere appreciation to Dr. A. W. Meyer, to whom I am indebted for assistance and suggestions during the progress of this study.

LUCY J. WATT

DEPARTMENT OF ANATOMY,
STANFORD UNIVERSITY

DETERMINATE EVOLUTION IN THE GENUS SPIRIFER

SINCE March, 1920, the writer has engaged in a study of variation and evolution in two groups of organisms belonging to the inclusive brachiopod genus *Spirifer*. Work first was done at the Walker Museum of the University of Chicago, and from September, 1926, to September, 1928, at the University of Cincinnati, under a National Research fellowship in the biological sciences. Since the latter date, results have been correlated and a manuscript report prepared which will be published by the Wagner Free Institute of Science of Philadelphia.

The Linnaean species *Spirifer orestes* Hall and Whitfield and *S. hungerfordi* Hall comprise two widely divergent groups within the genus *Spirifer*. The former fall within the *Aperturati* of Hall and Clarke, which include the genotype, *S. striatus* (Martin); the latter are rather primitive members of the section or subgenus *Choristites* Fischer. Both are characteristic of the uppermost Devonian (Hackberry) strata of Iowa, though closely related forms (kindly loaned by Dr. C. R. Stauffer) are found in the Martin formation of Arizona.

Since the description of *Spirifer hungerfordi* by Hall,[1] and *S. orestes* by Hall and Whitfield,[2] paleontologists have recognized that these two Linneans exhibit considerable variation or speciation, but no serious published effort has been made to distinguish them. Even in our account of the Hackberry fauna,[3] Mrs. Fenton and I merely called attention to the existence of such speciation and illustrated a few examples.

This study began, therefore, with a careful taxonomic revision, little attention being given to evolution. In the *Spirifer orestes* group (here designated a *phratry*) this revision is based primarily upon the striae, nodes and pustules which form the minute ornament of the shell, since they have been found to be much more reliable than gross characters of shape, plications, sinus or fold. In the *S. hungerfordi* gens, however, the minute ornament is essentially uniform, so that gross characters must be relied upon. In consequence, there is some discrepancy between the taxonomic units determined in the two groups, those in the former being much the more precise.

Although work at first was concentrated upon pure taxonomic differentiation, it soon became evident that the taxonomic units, when arranged stratigraphically, automatically were arranged in apparently determinate evolutionary series, distinct, parallel or homeomorphic, and non-contemporaneous. The existence of such series and a provisional interpretation of them were reported in June, 1926, although not published until 1927.[4] In September, 1926, a collection of about six thousand additional specimens, with exceptionally precise data, was secured from the late Mr. C. H. Belanski. Work was begun *de novo,* even the taxonomic units previously determined being put aside. They at once reappeared, however, as did the evolutionary series; and again it was found that series based only on characters of surface (in the *Spirifer orestes* phratry) showed regularly correlated changes in form and character and number of plications. The situation may be summed up as follows.

In the *Spirifer orestes* phratry, the primitive surface ornament consists of minute, subradial to oblique ridges or striae, which are not broken and which bear neither nodes nor pustules. In every one of the divisions (gentes, subgentes, species) into which the phratry may be divided there is an apparently determinate evolution of these striae involving three or

[5] H. D. King, "Some Anomalies in the Gestation of the Albino Rat (*Mus Norvegicus Albinus*)," *Biol. Bul.*, 24, 1913.

[6] F. B. Sumner, "Notes on Superfetation and Deferred Fertilization among Mice," *Biol. Bul.*, 30, 1916.

[1] *Geol. Iowa,* 1 pt. 2: 501, pl. 4, figs. 1a–k, 1858.

[2] *Ann. Rep. N. Y. State Cab. Nat. Hist.,* 23: 237, pl. 11, figs. 16–20, 1873.

[3] "Stratig. and Fauna of the Hackberry Stage of the Upper Devonian," 1924.

[4] *Univ. Chicago Abs. of Theses,* sci. ser. 5: 223–226, 1927.

more of the following steps: (1) primitive, continuous striae; (2) constriction of the striae, occasionally accompanied by swelling, resulting in the formation of nodes; (3) further constriction of these elevations, resulting in rows of round, generally hollow pustules; (4) loss of definite arrangement in these pustules, at least marginally; (5) enlargement of these scattered pustules into short spines. These stages are accompanied by a reduction, relative or actual, in the width of the shell, a consequent increase in tumidity, a reduction in the number and strength of the plications and (generally) a marked increase in the number of growth lamellae.

The progress of evolution, especially in forms which reach stage 4 or 5, may be traced minutely in the ontogeny of the shell. Moreover, there commonly is a close relationship between the duration of a stage in the evolution of a given line and its duration in the life of an individual, as measured in the amount of shell surface on which it is evidenced.

In spite of the regularity of these trends, they are not contemporaneous. One group, in an advanced stage of pustulation, will be contemporaneous with another in which stage 2 has been reached, and a third in which striae are primitive and continuous. In every line advanced stages of evolution, both in striae and gross characters, are followed by disappearance, and disappearance also is non-contemporaneous. These facts, plus a lack of evidence of progressive environmental change, negate the theory of natural selection, while the uniformly determinate, even predictable, nature of the changes, militates against heterogenesis.

It seems, therefore, that in the *Spirifer orestes* phratry we have numerous, parallel examples of determinate or orthogenetic evolution, operating independently of the environment and resulting regularly in extinction of the lines affected. Such evolution commonly is interpreted as racial senescence, although that theory generally has involved such factors as gigantism, multiplication of structures and extreme spinescence, which are lacking in the *Spirifer orestes* phratry.

There are several lines of evidence, however, which support Child's hypothesis of racial senescence through heritable, cumulative decrease in the rate of basal metabolism as an interpretation of these evolution trends.[5] One is the minute correlation between ontogeny and phylogeny, which strongly suggests a community of cause. Another is the fact that phylogerontic members of any given line more commonly show injury than do phyloephebic ones, and have repaired those injuries much less effectively. In the latter, valves fractured during neanic growth may be so well repaired that the injury is not shown ephebically, while in the former, injuries too small to be distinguished clearly commonly distort the entire shell. Finally, phylogerontic forms seem to have been extremely susceptible to physiologic disturbance, their shells bearing abundant and pronounced growth lamellae and constrictions. These, like incapacity for repair, seem to indicate a lowered metabolism in the organisms concerned.

Evidence gleaned from the *Spirifer hungerfordi* gens is less conclusive regarding precise trends than is that from the *S. orestes* phratry. On the other hand, it is quite as definitely negative toward theories of selection and environmental influence, since widely divergent groups develop contemporaneously in the same spots. Evidence from injury, repair and growth disturbance is virtually identical and affords the best indication that a common evolutionary process underlies the divergent trends just mentioned.

From the evidence here briefly summarized, a theory of the racial life cycle is advanced which may be stated as follows.

Stages in the life history of a race may approximate those in that of the individuals composing it, and in such cases, rest upon the same physiologic basis. Changes involved in racial origin, in such series, find their cause in genetic variations which increase the metabolic rate; those of differentiation and decline (racial senescence) in heritable variations which reduce that rate.

CARROLL LANE FENTON
UNIVERSITY OF BUFFALO

[5] "Senescence and Rejuvenescence," 193–194, 463–464, 1915.

CHANGES OCCURRING IN STORED ALCOHOLIC PLANT EXTRACTS[1]

PHYTO-CHEMISTS have used the alcoholic preservation method for the storage of plant materials for a considerable number of years. Surprisingly small, however, is the amount of work that has been done to explain the reasons for each step, and practically nothing has been done to check the effects of such a procedure on the various constituents to be estimated. There are such statements as, "Preserved in 80 per cent. alcohol," and "Calcium carbonate added to neutralize the acidity," and theoretical considerations are found to justify such statements. As previously stated, it is very hard to find analytical data to explain the reason for these steps. It is coming to be recognized that nitrogen fractionation must be completed on water extracts. A previous paper[2] from

[1] Published with the permission of the director of the Oklahoma Agricultural Experiment Station.

[2] J. E. Webster, "Effects of Storage on Alcoholic Extracts, I. Amino Acid Changes," *Plant Phys.*, 4: 141–4, 1929.

this station has shown that under certain conditions ordinarily met with, the alpha amino nitrogen percentage decreases while in storage. Work on the factors responsible for these changes is progressing but of necessity must cover a long period of time and involve a great number of factors. Several interesting results have been secured to date, and it is felt that they are of enough importance to the field of plant chemistry to be published prior to the main body of the work which will be published at a later date.

One of the most interesting facts discovered is that the term "calcium carbonate added to neutralize the acidity" is most uncertain. Plant samples prepared in the usual manner by adding an excess of $CaCO_3$ have been found in most cases to be distinctly acid, the amount of acidity, of course, depending upon the material preserved. Approximate hydrogen ion determinations have been made on a number of solutions using the colorimetric procedure, and they have been found to range from pH 4.6 to 6.0. The following figures may be given as an example of their acidity. Five cc portions of several of these samples were brought to approximate neutrality, using N/10 NaOH.

Plant	1	4.	drops	N/10 NaOH
"	2	3.	"	" "
"	3	4.	"	" "
"	4	8.	"	" "

From these figures it is at once apparent that the acidity varies considerably, and the solution being acid even when treated with $CaCO_3$, changes may result that we did not expect on theoretical grounds. Perhaps the acidity has little, if any, bearing on carbohydrate changes in these stored extracts, but until all the conditions surrounding this point are critically examined, we must hold such determinations at least open to question. A recent publication[3] takes note of this fact and brings alcoholic solutions to a pH of 5.8 to 6.0 using tenth-normal NaOH to neutralize the acidity of the extracts. This procedure must certainly be recognized as a great advance over the addition of an excess of $CaCO_3$.

While the importance of acidity is not so apparent in the carbohydrate analyses, in the nitrogen changes it is most important, as the following figures show, at least, on the amount of ammonia present. Only one set of figures is given but they are representative. Samples were prepared and analyzed as outlined in my previous work.[2]

[3] Nightingale, Addoms and Blake, "Development and Ripening of Peaches as Correlated with Physical Characteristics, Chemical Composition, and Histological Structure of the Fruit Flesh: III. Macrochemistry," N. J. Agr. Expt. Sta. Bull. 494, 1930.

TABLE I

pH 4.2		pH 8.+	
Date	NH_3	Date	NH_3
2–27–29	2.72	2–27–29	2.14
3–12–29	2.90	3–12–29	4.60
5–22–29	4.00	5–22–29	7.89
11– 7–29	4.62	11– 7–29	8.50

Celery extract in approximately 80 per cent. alcohol. Ammonia in terms of N/50 HCl.

From Table I we see that there is a continuous increase in the amount of ammonia and that this increase is much greater in the alkaline solution. In all the solutions examined (grapes, celery, lettuce, spinach) there has been found some increase in ammonia on standing, both in acid and alkaline solutions. In some, however, the increase has been small and perhaps in samples of other materials would be negligible.

No explanation of these changes can be given until further work is completed, but on the basis of the present work it does not seem that the increase in ammonia results from a deaminization of amino acids even though we do know that the amount of alpha amino nitrogen decreases in some of these solutions.

In conclusion it seems that this question of alcoholic storage has not received the attention it should and that to make our plant analyses of value when we use this procedure a host of questions bearing on this field should be answered. This laboratory is continuing its work, but the need for some satisfactory method of preserving plant material for analyses is so pressing that it offers a ready field to the experimenter, and one that should well repay the research workers.

JAMES E. WEBSTER

OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE

BOOKS RECEIVED

BROOM, R. *The Origin of the Human Skeleton.* Pp. iv + 164. Witherby. 10/6.

CLIFFORD, JAMES L. *Experiments in Atomic Science for the Amateur.* Pp. 119. 44 figures. Badger.

Library of Congress. *Report of the Librarian, 1930.* Pp. xvi + 420. Government Printing Office.

MACKAYE, JAMES. *The Dynamic Universe.* Pp. xi + 308. Scribner's. $3.50.

PAYNE, CECILIA H. *The Stars of High Luminosity.* Pp. xiii + 320. Harvard Observatory Monographs. No. 3. McGraw-Hill. $3.50.

RICE, STUART A., Editor. *Methods in Social Science. A Case Book.* Pp. xiii + 822. University of Chicago Press.

VOLTERRA, VITO. *Theory of Functionals.* Pp. xiv + 226. Blackie. 25/.

WILLIAMS, SAMUEL ROBINSON. *Magnetic Phenomena.* Pp. xxii + 230. McGraw-Hill. $3.00.